No. CLI. MAY 15, 1879. PRICE FOURPENCE.

JUN 2 1879

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

LONDON: HAUGHTON & COMPANY, 10, PATERNOSTER ROW, E.C.

Office:
16, UNION COURT,
OLD BROAD ST.,
LONDON, E.C.

JOHNSON & PHILLIPS,
TELEGRAPH ENGINEERS,
ELECTRICIANS, AND CONTRACTORS.

Works:
VICTORIA ROAD,
CHARLTON,
LONDON, S.E.

Manufacturers of all Telegraph Appliances, Materials, and Machinery for Making and Laying Submarine Cables, and Contractors for Underground & Aerial Telegraphs.

Iron Telegraph Buoys, Grapnels, both Patent and Ordinary; Centipedes, Creepers, Mushrooms, Sinkers, Cable Tanks, Picking-up and Paying-out Machinery, Dynamometers, Bow and Stern Gear, Steam and Hand Hauling Gears, Rope and Chain Fittings, Cable Drums, Splicing and Jointing Tools, &c., &c.

Machinery Designed and Constructed for the Complete Equipment of Telegraph Cable Factories and Vessels. Wire Testing Machines for Tension, Elongation, and Torsion. Special Wire Sounding Machines for Shallow and Deep Water.

All Apparatus and Material used in the Construction and Maintenance of

LAND LINES, viz.:—

INSULATORS—*Johnson & Phillips's* Patent Fluid Insulators, and all kinds of the ordinary form.

BATTERIES—Sole Makers of *Higgins'* Patent Bichromate Batteries, and all the ordinary forms. Contractors for the supply of Zinc and Carbon Battery Plates of special quality.

POLES—Wrought Iron or Composite Poles of various kinds.

MAKERS OF SPECIAL UNDERGROUND TORPEDO AND FIELD CABLES, WITH SINGLE OR MULTIPLE CORES.

Insulated Copper Wires, Strand and Ropes, taped or braided, for Electric Lighting purposes, also Carbon Rods.

ESTIMATES GIVEN FOR COMPLETE SYSTEMS OF ELECTRIC LIGHTING.

LIGHTNING CONDUCTORS ERECTED, TESTED AND MAINTAINED.

ELECTRIC LIGHT.

SIEMENS BROTHERS,

TELEGRAPH ENGINEERS,

MANUFACTURERS OF

SIEMENS' PATENT DYNAMO-ELECTRIC MACHINES, LAMPS, CARBONS, and all APPARATUS NECESSARY FOR WORKING THE ELECTRIC LIGHT FOR LIGHTING RAILWAY STATIONS, WHARVES, DOCKS, LIGHTHOUSES, SHIPS, FACTORIES, WEAVING SHEDS, YARDS, &C.

Manufacturers of Submarine Cables, Materials for Overground Lines, Iron Telegraph Posts, Insulators, Instruments, Batteries, Electric Mine Exploders, and Telegraph Apparatus of all kinds.

Contractors for laying Submarine Cables, for the erection of Land Lines, and for the establishment of Telegraphic communication generally.

Offices—12, QUEEN ANNE'S GATE, WESTMINSTER.
Works—CHARLTON PIER, WOOLWICH, KENT.
And at BERLIN, PARIS, St. PETERSBURG, and TIFLIS.

AN ENGINE WHICH WORKS WITHOUT A BOILER OR STEAM.

AVERAGE WEEKLY DELIVERY
(Including Continental)
OVER TWENTY ENGINES.
1,900 ALREADY DELIVERED.

The durability of these Engines is now established by experience, one of them having run night and day at the Hinckley Gas Works for over twelve months without any expenditure for repair; this being equal to about 2½ years average work. Over 1,600 already delivered. Very numerous Testimonials from Users including Engineers, Men of Science, and others, on application to the Makers. No trouble with Coal, Ashes, Smoke, Insurance, Water, or constant attendance. No glands to pack, for Water Gauges and Steam Gauges to watch.

STARTS AT A MOMENT'S NOTICE.

THE "OTTO" SILENT GAS ENGINE.

("Otto" and Crossley's Patents, 1876 and 1877.)

THEY ARE USED FOR ALL KINDS OF PURPOSES, CHIEFLY FOR HOISTING, PRINTING AND PUMPING.

Sizes									
Nominal Horse Power	½	1	2	3½	6	8	12	16	Offered.
Maximum Horse Power	1	1½	2½	4	9	12	18	24	

Prices include Cast-iron Stand, Turned Fly-wheel, & Driving Pulley; Water Vessel, Several Duplicates, & Gas Fittings (excepting Meter & Pipes).

WORKS & HEAD OFFICES:
Gt. Marlbro' St., Gloucester St.

CROSSLEY BROTHERS,
MANCHESTER.

LONDON HOUSE:
116, Queen Victoria St., E.C.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW,

Handsomely bound in cloth, gilt, Vols. I., II., III., IV., V., and VI. Price 10s. 6d. each. Nearly all the back numbers may be had through any Bookseller, or of the Publishers. Subscribers' numbers bound in black cloth, gilt, 2s. 6d. Binding Cases, 2s.

HAUGHTON & CO., 10, PATERNOSTER ROW, E.C.

ANOTHER NOVELTY.

The Electric Light in your own Homes

Price 1s. Complete, or post free 15 stamps.

(Prise Medal Paris Exhibition, 1878.)

This wonderful Lamp solves the great problem which has hitherto baffled all the scientific men, even the famous inventor, Mr. Edison, namely, how to produce a

CHEAP ELECTRIC LAMP.

Our Lamp, being automatic, will burn for hours without attention, giving a light of perfect steadiness and great brilliancy. It is enclosed in a globe of annealed glass, to tone down the intense rays; and being simplicity itself, and adjusted ready for immediate use, it can be set in action by a child, without previous knowledge of electricity. The Lamp stands on an ornamental base, the mechanical parts are made entirely of brass, and the "Reynier" carbons are used for producing the light. A book of instructions is enclosed with each Lamp, enabling any person to construct our novel and powerful battery in a few moments at a trifling cost.

Our new Chromo-litho Catalogue, 30 pages of illustrations, post free 7 stamps, contains all the Electrical, Magical, Chemical, Pyrotechnical, Mechanical, Comical, Diabolical Novelties we Manufacture.

THE SCIENTIFIC TOY AND GENERAL NOVELTY COMPANY,
SUN WORKS,
32a, Cow Cross Street, London, E.C.

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VII. MAY 15, 1879. No. CLI.

CONTENTS:

	PAGE
The Electric Light	159
Muirhead's Duplex System, by A. Muirhead (*illustrated*)	160
The Cantor Lectures: W. H. Preece	162
Stearns' Submarine Cable Duplex System (*illustrated*)	163
A New Electric Marvel	163
The *Soirée* of the Royal Society	164
Edison's Electric Candle (*illustrated*)	164
The Electric Light at the Albert Hall	166
On Electric Lighting, by Dr. John Hopkinson, F.R.S., M. Inst. M.E. (*illustrated*)	167
Notes	170
Proceedings of Societies	171
General Science:—	
"Engines for Working Electric Light Machines" (*illustrated*)	172
City Notes	173

TO INVENTORS.

MESSRS. BREWER & JENSEN, British, Foreign, and Colonial Patent Agents, give prompt personal attention to all matters intrusted to them. Office for Patents, 33, Chancery Lane, W.C. Established 1844.

PATENTS FOR INVENTIONS.

ROBERTSON, BROMAN, & Co. (established 50 years) continue to obtain Patents for Inventions. Pamphlet, containing special advice, gratis or by post. 166, Fleet Street, London.

GEOLOGY.—In the Preface to the Student's ELEMENTS of GEOLOGY, by Sir Charles Lyell, price 9s., he says:—"As it is impossible to enable the reader to recognise rocks and minerals at sight by aid of verbal descriptions or figures, he will do well to obtain a well-arranged collection of specimens, such as may be procured from **Mr. TENNANT** (149, Strand), Teacher of Mineralogy at King's College, London." These Collections are supplied on the following terms, in plain Mahogany Cabinets:—

100 Specimens, in Cabinet, with 3 Trays	£2	2	0
200 Specimens, in Cabinet, with 5 Trays	5	5	0
300 Specimens, in Cabinet, with 9 Drawers ..	10	10	0
400 Specimens, in Cabinet, with 13 Drawers ..	21	0	0

More extensive Collections at 50 to 5,000 Guineas each.

Messrs. H. A. HARBOROW & H. SPAGNOLETTI,

ELECTRIC TELEGRAPH ENGINEERS,

CONTRACTORS AND MANUFACTURERS,

4, Circus Street, Marylebone, W.

Makers of Block Instruments, Single and Double Needle Instruments, Coils for same with Induced Needles. Lines constructed and maintained. Batteries of every description. Electric Bells, Indicators, Thief and Fire Alarms for private houses, banks, hotels, warehouses, &c., &c. Lightning Conductors. All kinds of Electrical Mining Apparatus. H. and H. S. draw attention to their Bells, &c., especially adapted for mines. Models made. Experiments carried out.—4, Circus Street, Marylebone, London, W.

BLOCK TELEGRAPHS AND ELECTRIC INTERLOCKING SIGNALS.

TYER & COMPANY

Respectfully invite the attention of Railway Directors, Managers, and Engineers to their important improvements in "Block" Telegraphs, especially to their new system (Patent 1874, in conjunction with Messrs. SAXBY & FARMER), inspected and improved by Captain TYLER, on behalf of the Board of Trade. By the use of this appliance, a signalman who receives a telegraphic indication of a line blocked from the signalman in advance, cannot possibly give a contrary signal upon the outside semaphore to the engine-driver.

"Such is the latest development of railway signalling, which is worthy of careful attention, constituting, as it does, a marked advance upon the ordinary block system."—*The Times.*

Office and Works—4, OLD STREET, GOSWELL ROAD, LONDON.

MACHINERY for covering Telegraph Wire with Silk, Cotton, Flax, Hemp, India-Rubber, Gutta-Percha, &c. Wire Stranding Machines. Complete sets of Machinery for the Manufacture of Telegraph Cables.

THOS. BARRACLOUGH, 97, BRIDGE STREET, MANCHESTER.

C. & H. MILCHSACK,

HEDWIGSTHAL, PRUSSIA,

MANUFACTURERS OF

MORSE TELEGRAPH PAPER.

Contractors to H. M. Post Office, the German, Dutch, Swedish, Swiss, and other Governments, various Telegraph and Railway Companies, &c., &c.

For samples and prices, apply to our Sole Agent for Great Britain and Colonies,

Mr. MAX SABEL, 2, Coleman St. Buildings, City, E.C.

H. G. GOODWIN,

42 & 43, Kirby Street, Hatton Garden.

WOOD TURNING AND PATTERN MAKING

Special facilities for executing all kinds of Woodwork for Electricians.

CULLEY'S PRACTICAL TELEGRAPHY.

In One Volume, 8vo., with 132 Woodcuts and 18 Lithographic Plates of Machinery and Apparatus, price 16s.

A HANDBOOK of PRACTICAL TELEGRAPHY, By R. S. CULLEY, Member Inst. C.E. (Adopted by the Post Office and by the Department of Telegraphs for India.) The Seventh Edition, thoroughly revised and enlarged.

London: LONGMANS & CO.

Professors & Experimentalists.

W. STONE,

MATHEMATICAL, SURVEYING, AND OPTICAL INSTRUMENT MAKER,

44, *Gloucester St., Queen's Square, Bloomsbury,*

Works out all kinds of difficult experimental and scientific work.

TELEGRAPH INSTRUMENT CASES.

GEORGE BEECH,

10, SANDRINGHAM RD., HIGH ST.,

KINGSLAND,

Continues to supply Railway and Telegraph Engineers with every description of Telegraph Instrument Cases, Single Needle, Block, Bell, Switch, &c. The material and workmanship of first quality and guaranteed.

Terms moderate for Cash.

THE

"EMPRESS" WATER MOTOR

Price List and Power of the "Empress" Motors at Various Pressures, April, 1879.

No.	Size of Jet.	Diameter of Wheel.	20 to 40 lbs. Pressure H.P.	40 to 60 lbs. Pressure H.-P.	60 to 80 lbs. Pressure H.-P.	Consumption of Water per Hour. 20 to 40 lbs. Pressure Galls.	Consumption of Water per Hour. 60 to 80 lbs. Pressure Galls.	Size of Driving Pulley.	Size of Supply Pipe leading up to Jet.	Pipe to Carry Waste Water away.	Revolutions per Minute.	Price of Motor, with Jet.
2	3-32 in.	11 in.	For Sewing and other Light Machinery.			40 to 70		2½ in. gut.	¾ in.	1 in.	1000 to 3000	£3 3s.
3	3-32 in.	14 in.				40 to 70		3¾ in. gut. diam. width.	¾ in.	1 in.	900 to 2500	£4 10s.
4	3-16 in.	18 in.	¼ to ½	½ to ¾	¾ to 1	150 to 200	250 to 350	5 in. 2½ in.	1¼ in.	2½ in.	800 to 2000	£8 0s.
5	3-16 in.	23 in.	½ to 1	1 to 1½	1½ to 2	150 to 200	250 to 350	7 in. 2⅝ in.	1½ in.	2½ in.	600 to 1500	£15 0s.
6	¼ in.	30 in.	1 to 2	2 to 3	3 to 4	300	500	9 in. 2¾ in.	2 in.	3½ in.	400 to 1200	£25 0s.
7	2 of $\frac{3}{16}$ in.	2 of 30 in.	2 to 3	3 to 4	4 to 5	400	700	9 in. 2¾ in.	2½ in.	5 in.	350 to 1000	£35 0s.
8	2 of ¼ in.	2 of 36 in.	3 to 4	4 to 5	5 to 6	600	1000	9 in. 2¾ in.	2½ in.	6 in.	300 to 900	£45 0s.

MANUFACTURED ONLY BY

E. S. TAYLOR & CO.,

WORKS—111 & 113, BLANDFORD STREET, } LIVERPOOL.
OFFICES—9 & 10, SHEFFIELD BUILDINGS, 89, VICTORIA STREET, } LIVERPOOL.
" METROPOLITAN BUILDINGS, QUEEN VICTORIA STREET, LONDON.

A. COMBE & CO.,

31 & 32, KIRBY STREET, HATTON GARDEN, LONDON.

MANUFACTURERS OF SCREWS

OF ALL KINDS, AND SMALL WARES FOR

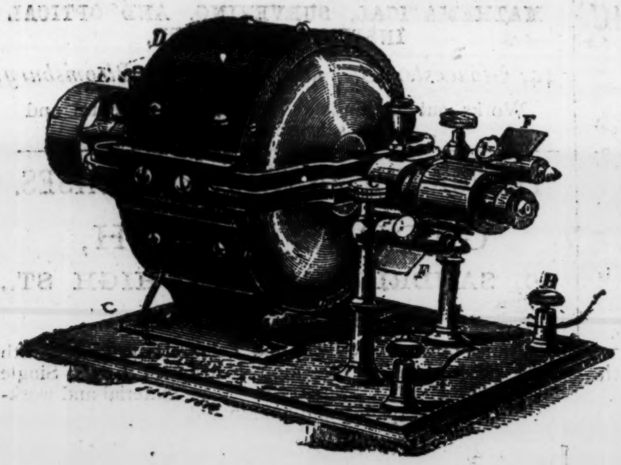
Electrical, Telegraphic, Optical, Scientific, Philosophical, Surgical, and Musical Instruments

ENGINEERING, &c., &c. TURNERY IN ALL METALS.

First-class work guaranteed. Estimates on application.

THE AMERICAN NICKEL COMPANY,

41, QUEEN VICTORIA STREET, LONDON, E.C.



NICKEL PLATING SOLUTIONS.

PURE NICKEL ANODES.

Finest American Polishing Lathes, Material, and Chemicals.

STEAM ENGINES AND COMPLETE OUTFITS.

The **DYNAMO-ELECTRIC MACHINE,** for depositing Nickel, Silver, Gold, Copper, &c.

Pure deposits of Nickel guaranteed, and the most practical instructions to purchasers of outfit.

ESTABLISHED **THE EUROPEAN MAIL** 1843.

Is the leading Title of Eight totally distinct Papers, circulating as follows:—

EDITION.			No. of Issues Annually.
A.	throughout	the West Indies, Central America, Mexico, Chili, Peru, &c.	24
B.	"	South Africa, St. Helena, Ascension, &c.	52
C.	"	North America, *i.e.* the United States, Canadian Dominion, British America, Cuba, &c.	12
D.	"	the Brazils and River Plate, Azores, &c.	24
E.	"	the East, *i.e.* India, Burmah, Egypt, China, Japan, Ceylon, Penang, Singapore, Siam, Sumatra, Java, Borneo, Philippine Islands, Mauritius, &c.	12
F.	"	Great Britain and the Continent	12
G.	"	Australia, New Zealand, Fiji, &c	13
K.	"	the West Coast of Africa, Madeira, &c.	12
		Total ...	161

Each Edition of THE EUROPEAN MAIL contains every item of intelligence from Mail to Mail, specially affecting the country or colony for which it is published, with an exhaustive *resume* of Home and Continental Politics, Science, Art, and Social News, together with a retrospect of Commercial transactions in Great Britain and on the Continent, thereby rendering it at once the highest commercial authority, the most complete Newspaper despatched from England, and the best medium for the insertion of Advertisements of all desiring to cultivate trade in all Foreign and Colonial Markets.

Advertisements inserted in the Series come under the notice of the reading public of the whole civilised world.

Specimen Copy of any Edition, with particulars of Subscription of Tariff for Advertisements, forwarded on application to THE PUBLISHER.

THE EUROPEAN MAIL, Colonial Buildings, Cannon St., London, E.C.

NEWALL'S PATENT LIGHTNING CONDUCTORS.

Experience, accumulated since the time of Benjamin Franklin, proves conclusively that a Conductor made of Copper, of adequate size, is the best of all appliances for the protection of every description of Building from the destructive effects of Lightning.

NEWALL & CO.'S PATENT COPPER-ROPE LIGHTNING CONDUCTOR,

As applied to all kinds of Buildings and Shipping in all parts of the world with unvarying success, is the most reliable, most effective, and cheapest conductor offered to the public.

It is simple in its application, no insulators being required; and it costs only ONE SHILLING per foot for the standard size, which is safe in any storm.

SOLE PATENTEES OF UNTWISTED WIRE ROPE.

Manufacturers of Iron and Steel Ropes for Colliery and Railway Purposes. Rigging Ropes, Guide Ropes, &c.

GILT AND SILVER CORD FOR HANGING PICTURES. IRON, STEEL, AND COPPER CORD FOR CLOCK AND SASH LINES, &C.

R. S. NEWALL & Co., LONDON, 130, STRAND, W.C.

LIVERPOOL, 36, Waterloo Road; GLASGOW, 68, Anderston Quay; MANUFACTORY, Gateshead-on-Tyne.

THE ECLIPSE SILENT GAS ENGINE.

☞ Power being imparted at each revolution in exact proportion to the work to be done, this Engine runs with a regular speed, which makes it the best for the Electric Light.

REPORT FROM THE PYRAMID ELECTRIC COMPANY.

LONDON, *April 12th*, 1879.

The small ($3\frac{1}{2}$ h.-p.) Gas Engine supplied by you for conducting the Experiments with the Electric Light before the Docks' Committee at Bathurst Basin, Bristol (for illuminating the harbour, transit sheds, and wharfs), worked a **large (A size) Gramme Dynamo Machine,** and also a small M Gramme ditto, **very steadily,** producing **a good STEADY LIGHT;** but I am not in a position to say how much gas this engine consumed, because we had not time to fix a meter to measure it.

Yours faithfully,

W. BLANCH BRAIN.

PATENTEES AND SOLE MANUFACTURERS:

LOUIS SIMON AND SON, NOTTINGHAM.

THE TELEPHONE COMPANY (LIMITED),

36, Coleman Street, London, E.C.

SOLE PROPRIETORS OF BELL'S AND OTHER PATENTS.

Telephones and all necessary instruments supplied for domestic or business purposes, on sale or rental. Estimates can be obtained for fitting up telephonic communication in Mines, Factories, Workshops, or Private Dwellings; also for lines of wire communicating between Light-houses and the shore, Shipping Offices and Vessels in Port.
Noblemen's Mansions and their Lodges, Stables or Game Keepers residences, &c., &c.

AGENTS WANTED. A LIBERAL DISCOUNT ALLOWED TO THE TRADE.

Proceedings will be taken against all persons selling or using any Telephones or otherwise infringing the Company's Patent.

Applications for Price Lists or further information to be made to the Manager.

W. T. HENLEY,

TELEGRAPH ENGINEER AND CONTRACTOR.

MANUFACTURER OF SUBMARINE CABLES.

Wire and all Telegraphic Stores, also Galvanised and Corrugated Iron Sheets.

8, Draper's Gardens, Throgmorton Street, London.
WORKS—NORTH WOOLWICH.

M. THEILER & SONS,

TELEGRAPH INSTRUMENT MANUFACTURERS,

86, *CANONBURY ROAD, LONDON, N.*
MANUFACTORY—ALWYNE LANE, N.

Specialties:—Patent Polarized Relays for Cable and Land-line Working. Submarine Recorders and Keys. Improved Morses, Type, and A B C Instruments. Electro-Motors, Rheostats.

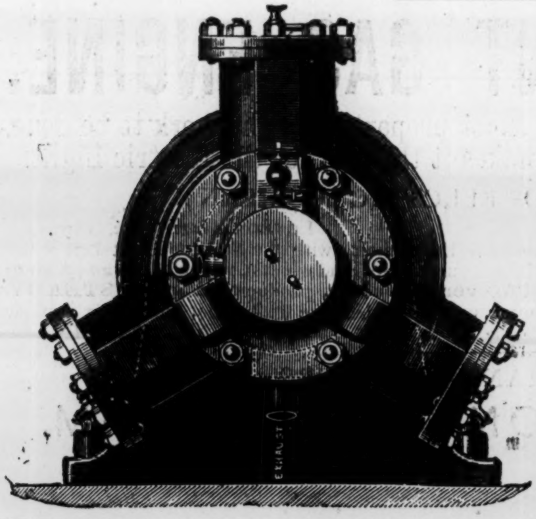
THEILER'S NEW SOUNDER, Now Ready.

INVENTIONS CARRIED OUT. ESTIMATES FREE.

PETER BROTHERHOOD,

ENGINEER,

56 & 53, COMPTON STREET, GOSWELL ROAD, E.C.



SILVER MEDAL, PARIS EXHIBITION.

PATENT 3-CYLINDER ENGINES

AS USED BY

Siemens, Gramme, and Wilde,

FOR DRIVING

DYNAMO-ELECTRIC MACHINES

THE TELEGRAPHIC JOURNAL AND ELECTRICAL REVIEW.

VOL. VII.—No. 151.

THE ELECTRIC LIGHT.

THE Electric Light has had a jubilee; not indeed one of those silver weddings or golden weddings which are so frequent just now among successful sovereigns and public men, but a coming-of-age festival, which stamps it as a practical necessity of civilized life. For it is in the light of a jubilee that we must regard the magnificent exhibition of electric lighting apparatus of all nations which was inaugurated by the Prince of Wales last Wednesday evening in the Albert Hall. Mr. W. H. Preece, who from the stentorian power of his lungs, and his well-known facility as a popular expositor, was both mentally and physically well chosen to deliver the opening lecture, and the President and Council of the Society of Telegraph Engineers, deserve the thanks of electricians in general for conceiving the exhibition and carrying it out to a successful issue. The Prince of Wales, in consenting to preside over it, gave it a dignity which otherwise it would have lacked in the eyes of the people, and, by this courteous act, has helped to ingratiate himself with our profession.

The past year has been an important era in the history of the electric light, perhaps the most important it ever experienced. Hitherto the electric light had led a dilatory and tentative existence, with occasional spasmodic bursts of vigour which as quickly died out again. But during the last twelve months it has developed so rapidly that, instead of being a thing almost unknown to the world at large, it is the subject of every person's talk, and the recognised illuminant of the future. It has established itself as a formidable rival to gas: a rival whose permanency is assured, and whose improvement only is a matter of speculation. During the past year it has accomplished its majority, and it speaks well for the coming light that the event has been so highly distinguished. We can imagine the ill-disguised smile, or rather sneer of contempt, with which a gas director would read the foregoing complimentary lines. The gas companies have now fallen into a habit of utterly repudiating the electric light. From panic they have oscillated to sheer scepticism, and, secure in the failure of Mr. Edison's system, they ignore all others. Complaints are rifer than ever about the poor quality of gas, and the unprecedented number of cubic feet which everybody has been burning of late. It is as if the gas had taken upon itself to be revenged for the scare which the new electric light gave it, and had played tricks on the meters. But gas directors ought to know that it is as unwise to pooh-pooh the electric light now as it was hasty to dread it before. Jablochkoff's system has been tried in London for street lighting, and found to be more expensive than gas; but that is a very insufficient basis to condemn an enemy upon. Jablochkoff's system is only one of twenty different systems which have yet to be tried for street lighting; and, further, each of these, including the Jablochkoff, is capable of improvements, which only suggest themselves when the apparatus is put on trial. The electric light is progressing in the streets of Paris, and it is being extended to other cities in France, notably Lille. In France gas is dearer than in England, hence the difference in cost is less marked than with us. The beauty of the electric light also enhances its value, in Paris at least, more than in London, where the brilliant beams, instead of lighting up beautifully sculptured boulevards and pellucid air, only unmask the hideousness of our dingy brick thoroughfares and murky atmosphere.

That the electric light is no longer to be despised by the gas companies is amply proved by the statement made by Dr. Siemens before the Committee on Electric Lighting, now sitting in the House of Commons, to the effect that the firm, of which he is the head, had manufactured £57,000 worth of electric lighting apparatus during the past year. Factories of all kinds, in different parts of England and the continent, are adopting the electric light, as being not only superior but cheaper than gaslight. That the electric light when produced by a few intense sources and properly diffused is far more economical than gas for the illumination of large halls and workshops, is proved by the ordinary lighting of the Albert Hall, where five Siemens lamps, costing £2 10s. per night and yielding a light equal to 45,000 candles, have superseded some 3,000 gas burners which formerly cost £7 per night in consuming 42,000 cubic feet of noxious gas. Electrically lit factories and halls may not much diminish the total revenue of the gas companies; but these factories and halls are only the beginning of a conquest which will gradually extend itself and may ere long spread not only to streets but to dwelling-houses.

It is true that Mr. Edison has not fulfilled the extravagant expectations which his own hasty acts engendered in the public mind. But we are much mistaken in Mr. Edison if he does not in time attain a measure of success which will, to a certain extent at least, make good his words. He is sanguine, but he is also persistent; he is probably even rash; but he is very ingenious; moreover, he is young, and the declared foe of the gas companies, therefore let them not despise him. Half of his reputation depends on his success in electric lighting; and, despite his seeming failure thus far to render it practicable, we cannot but think that he has shown the instinct of a true inventor in seizing upon the incandescent mode of electric lighting for domestic purposes, and abandoning the voltaic arc.

Whether Mr. Edison be successful or not, however, and, according to latest reports, he himself states that he is, there are hundreds of other inventors of tried ability at work upon the problem of electric lighting; and that their success thus far is no mean one, has been amply demonstrated by the recent splendid exhibition at the Albert Hall.

MUIRHEAD'S DUPLEX SYSTEM.

By A. MUIRHEAD.

So much has been written upon the subject of "duplex" telegraphy during the last few years, that it will be unnecessary for me to explain here how it is that two messages can be sent in contrary directions along the same wire simultaneously. A short outline of the history of this method of doubling the working capacity of a line may not, however, be amiss.

Dr. Gintl, a director of Austrian telegraphs, may be regarded as the founder of duplex telegraphy. In 1853, he described his system to the Academy of Sciences, Vienna, and tried it practically on a land-line between that city and Prague. In this original system the receiving instrument is placed between the battery and line, in such a position, that when the circuit is completed, by closing the key, the current flows through the receiving instrument into the line. With a receiving instrument, as ordinarily constructed, this current would produce a signal, but as it is essential for duplex working that sending from a station should not affect the instrument at that station, Gintl wound his instrument in a reverse direction with a second wire, and in order to counteract the effect of the signal current on the needle, he caused the current from a second, or "compensating" battery, to pass round this second coil. By means of resistance coils he adjusted the current in the compensating circuit till it exactly neutralised the effect of the signal current in the main circuit. The signal key being fitted with double points closed both circuits at the same time. Thus the receiving instrument was guarded against the influence of the sending currents and preserved free to indicate the received currents.

In 1854, Gintl's method was greatly improved by Herr Carl Frischen, a telegraph engineer of Hanover, who made the receiving instrument "differential," in other words, instead of winding it with two dissimilar wires as Gintl had done, he wound it with two wires as similar as possible but in contrary directions. By this devise he was able to employ a single battery, in sending one-half of the current through one coil of the instrument into the line, and the other half through the other coil into the compensating circuit, which was made equivalent in resistance to the line itself. This "Differential Method," as it is called, appears to have been re-invented a few months later by Messrs. Siemens and Halske, of Berlin, and is, therefore, sometimes termed the Frischen-Siemens method. It was tried in Prussia, soon after its invention, but gradually fell into disuse through a difficulty in maintaining the equivalence of the real and the artificial or compensating lines.

In 1863 M. Maron of Berlin adapted the principles of the "Wheatstone Balance" to duplex working, and as this arrangement of the apparatus is that chiefly employed in connection with Muirhead's system, I will describe it in some detail. Fig. 1 represents a theoretical plan of the connections in the "Wheatstone Balance Method" of duplex working. The proportional resistances *r r'*, are usually made equal to each other, so that by the principle of the Wheatstone Balance, the artificial line must also be made equal to the actual line. When this is accomplished, a signal current, sent from the battery on manipulating the key, will have no effect on the receiving instrument placed in the diagonal or "bridge wire" *c d*. It will simply divide itself at the point *b*, one-half flowing by the branch *r* into the real line, and proceeding to the distant station, while the other half flows by the branch *r'* into the artificial line, and so to earth. The potential at the points *c* and *d* being equal, there will be no cross current through the bridge wire, and a balance upon the receiving instrument will be obtained. The home-sending will, therefore, not disturb the home-receiving instrument; but at the same time, a signal current coming in from the distant station will upset this balance and produce a signal.

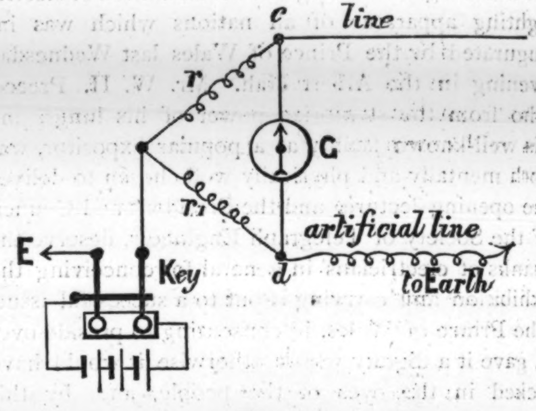


FIG. 1.

This Wheatstone Balance method also failed in practice because of the difficulties met with in keeping the artificial line equivalent to the actual one. Weather changes caused the resistance of the latter to vary; but the principal trouble lay in compensating for the static induction of the line.

It is well known that a line of electric telegraph, like a Leyden jar, has capacity and takes a certain definite time to charge; and the larger the line the longer is this time. But in order to make a perfect balance on the instrument this period of charging should be the same or nearly the same for the artificial as for the real line. The importance of increasing the capacity of the ordinary wire resistances used in determining the balance, seems to have been recognised first by De Sauty, who employed condensers in some experiments made with the differential method of Frischen-Siemens on a line between London and Birmingham, in 1855. Mr. Joseph Stearns, an American, who revived the question of duplex telegraphy in 1868, experienced the same difficulty at first in balancing long land lines with ordinary resistance coils of small capacity, and during his trials on the long American lines the addition of a condenser was suggested in order to increase the capacity of the artificial line. This led at once to the successful application of duplex on long land lines. The "kick" jerk, or false signal, made on the receiving instrument on closing the battery key by the sudden static charge due to the capacity of the actual line, was neutralised by the equally sudden charge into the condenser attached to the artificial line producing an impulse in the opposite direction. Attention now begun to be turned to duplex on submarine cables, a far more difficult problem to solve than that on land lines. On land lines the instruments are not worked up to the full carrying capacity of the line, whereas on cables they are, and the highly sensitive instruments of Sir William Thomson, the mirror galvanometer and siphon recorder, which are generally used on cables, respond to much less variations of current than are required to form signals on land line instruments. The balance on land lines need not, therefore, be so perfect as it requires to be on submarine cables. Again the static induction of a cable is far greater and more complex than that of a land line, hence the inductive "kick" is of a far more violent and inimitable character on a cable.

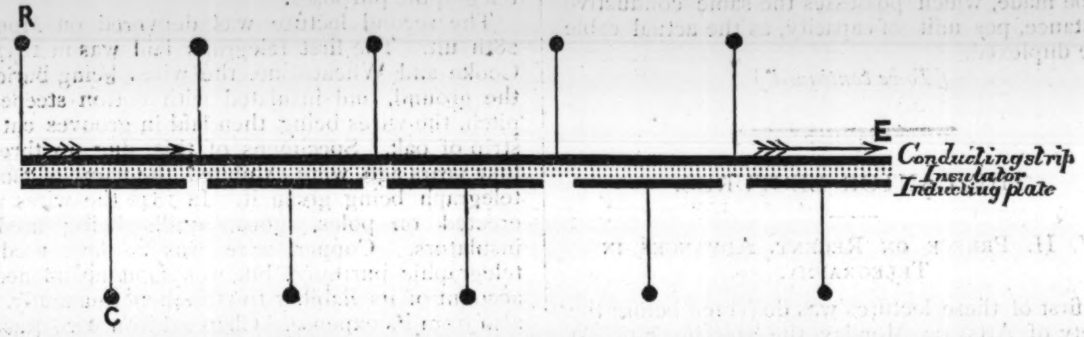
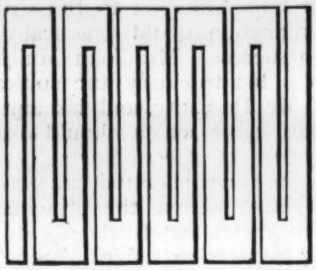


FIG. 2.

The experiments of the writer and Mr. Herbert A. Taylor in connection with this subject have disclosed the fact that a current enters a cable in a peculiar vibratory manner, necessitating a far closer imitation of the first portion of the cable at the beginning of the artificial line than one anticipates at first.

In 1872 attempts were made by De Sauty to apply duplex working to submarine cables. Mr. De Sauty endeavoured to "duplex" the Lisbon to Gibraltar cable by means of an artificial line, formed of a series of resistance coils with condensers attached to different points of the circuit, a combination which was patented by Mr. C. F. Varley, as far back as 1862, as an artificial cable or "test circuit." Mr. De Sauty's trials indicated that some closer approximation to the real cable than such a combination could practically afford was necessary to success. Mr. John Muirhead, junior, in 1873, was led to study the subject by these attempts of Mr. De Sauty, and his aim was to produce a model cable which should exactly imitate the actual one. In the following year, October 23rd, 1874, he first patented an artificial cable, which has since become the principal feature in what is now known as Muirhead's duplex system for working submarine cables. Since then the system has been developed and applied by Mr. Herbert A. Taylor, C.E., and by the writer. All the long cables of the Eastern Telegraph Company, between England and Bombay, have been duplexed on this system, as well as the Direct United States cable, making a total of over 10,000 miles of cable. The first cable "duplexed" was the Marseilles to Bona section, across the Mediterranean, in 1875; the latest was the Madras to Penang section of the Eastern Extension Telegraph Company, in the latter part of last year.

The system includes both a novel artificial line or model cable, and various adjustments for bringing the first part of the artificial line into close equivalence with the first few knots of the cable, and for perfecting the balance generally. Like a real cable, the artificial line is a continuous conductor of uniform capacity throughout its length, and is best named an "inductive resistance." It is formed by taking two strips of tin-foil, and laying one over the other but separated from it by a film of insulating material such as paraffined paper. One strip forms the conducting circuit of the artificial line; the other forms the outer or inductive coating, and is connected to earth. The current is passed through the conducting strip, and exposed throughout its entire length to induction on the other strip or sheet in the same way that the current in the conductor of a cable is subjected to induction on the earth. This mode of formation is shown in fig. 2, which represents a portion of the artificial cable. The conducting strip is, as will be seen, continuous, but terminals R are connected to it at regular intervals, which include a certain resistance. The inducing plates, or rather groups of plates, are, of course, diconnected from each other, but each set is connected to its special terminal C; the whole series of terminals, C, being put to earth. Each pair of resistance terminals combined with the corresponding capacity terminal opposite, thus form an element of the series or unit of the artificial line, equivalent to a certain number of knots of the cable, say ten. By this mode of construction, a compact model cable can be made, which possesses the same conductive resistance, per unit of capacity, as the actual cable to be duplexed.



ACTUAL SHAPE OF CONDUCTING STRIP.

(To be continued.)

THE CANTOR LECTURES.

W. H. Preece on Recent Advances in Telegraphy.

The first of these lectures was delivered before the Society of Arts, on Monday, the 21st instant. At the commencement of the lecture it was pointed out that light, heat, electricity, magnetism, &c., were all forms of energy, and are convertible the one into the other, as was shewn by a battery heating a platinum wire, exciting an electro-magnet, decomposing water, &c. In electro-telegraphy, the energy from a battery was caused to produce signals. The battery—the source of electricity—had a variety of forms; in the postal telegraph service, three kinds of Daniell battery were employed, viz.: the "Ordinary," introduced by Mr. John Fuller, which consisted of cells formed in a trough by slate partitions covered with marine glue, each cell being divided by a porous partition, the zinc plate being in one compartment, and the copper in the other. The "Chamber," introduced by Mr. Muirhead, had flat, porous cells, instead of the porous partitions of the Ordinary. The "U.K.," so called from its having been employed by the United Kingdom Co., had round cells, with round zincs and coppers. The Leclanché and the bichromate battery of Mr. John Fuller was also largely employed. At the Central Telegraph Station, St. Martin's-le-Grand, the number of cells worked was as follows:

	Cells.
Ordinaries	500
Chambers	12,750
U.K.'s	2,450
Leclanché's	500
Bichromates	1,650

giving a grand total of nearly 18,000 cells.

The cost of maintenance of these cells was as follows:

	s.	d.	
Ordinaries	0	6	per cell.
Chambers	1	0	"
U. K.'s	1	1	"
Leclanché's	1	0	"
Bichromates	1	0	"

The various defects to which each of these batteries were liable to were pointed out, and their practical management described. It was stated that England is very far ahead of other countries as regards battery arrangements. The "open" and "closed" circuit methods of working were explained, and also the "universal" system of working several circuits from one set of batteries was alluded to; this system was being extensively adopted in England, and with success. Currents generated by thermo-piles were not found to be successful, as the forms of thermo-piles tried had all failed after continued use. Dynamic electricity, although promising, had not as yet made any advance for telegraphic purposes.

The second lecture was delivered on Monday, 28th ult. The first telegraph laid was in 1837, by Cooke and Wheatstone, the wires being buried in the ground, and insulated with cotton steeped in pitch, the wires being then laid in grooves cut in a strip of oak. Specimens of this, dug up three or four years ago, were exhibited, the name of "fossil" telegraph being given it. In 1840 the wires were erected on poles, goose quills being used as insulators. Copper wire was at first used for telegraphic purposes, but was soon abandoned on account of its liability to stretch permanently, and also from its expense. Charcoal iron wire was also used, but was found to be too expensive. But little attention was at first paid to the conductivity of the wire employed, the No. 8 iron wire at first used, having a resistance of 20 ohms. per mile. About the year 1870 the quality supplied gave a resistance of 15 ohms. per mile, and at the present day, wire of 11 ohms. resistance per mile was obtained. The wires generally employed were of No. 4, No. 8, and No. 11 gauge.

Iron wire in passing through towns was protected from corrosion by a hemp covering well tarred; copper covered wire has also been tried in South Wales, but only lasted three years, as the covering cracked. Several kinds of insulators have been used. At the present time, Varley's brown ware and Cordeaux's screw insulator were in extensive use. The number of insulators that required replacing annually was 86,000. Insulation was very difficult to maintain in England on account of the moist climate; near the sea-coast especially, the leakage was very great, the insulation resistance per mile frequently going as low as 20,000 ohms. per mile. The number of poles per mile employed varied from about 22 for light extensions to 30 for very heavy lines. The best preservative for the timber was creosote; some poles thus preserved and set up on the Portsmouth line being still in good condition. Iron poles, except for special purposes, were too expensive. The Norway pine was the wood generally used for poles. Each pole was earth wired, and had wire twisted round each arm two or three times, and connected to the earth wire, to intercept leakage from wire to wire, which caused "weather contact" in wet weather. Great difficulty was found in preventing leakage at the terminal poles, and a new terminal for the purpose was under trial on the principle of the Johnson and Phillips' oil insulator. The underground work in towns was gutta-percha wire, No. 7 size, the copper weighing 39 lbs. per mile, and the gutta-perch 46 lbs. The gutta-percha wire lasted about 20 years in the streets.

The mileage of line and wire at present in use in England is as follows :—

	Land lines.	Wire lines.
Road	11,055	38,821
Rail	12,952	58,127
Canal	432	4,123
Underground	446	9,024

giving a total of 24,885 miles of line, and 110,095 miles of wire. The total length of the cables in the postal telegraphs was 3,809 miles. As regards the relative costs of underground and open work, it was stated that the former was three or four times as expensive as the latter.

STEARNS' SUBMARINE CABLE DUPLEX SYSTEM.

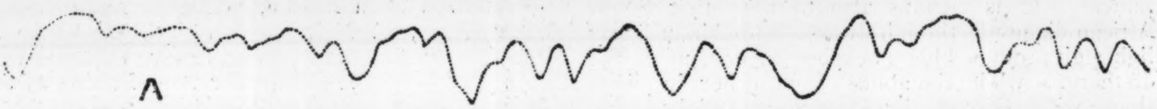
THERE can now be no doubt that submarine duplex telegraphy has fairly passed the experimental stage and is a practical success even as regards long cables. The difficulties which stood in the way of duplexing the long ocean cables seemed almost unsurmountable, and the feat was judged by many to be impossible. The success which has attended the labours of Messrs. Muirhead and Stearns, has practically set the matter at rest, and it is practically demonstrated that the longest cable ever likely to be laid can be duplexed. Very little is at present known of the details of the methods employed for effecting the end in view, in consequence of the question of the patent rights involved not having been settled; but we hope soon to make them clear.

As is well known, Mr. Stearns has lately turned his attention to the subject of duplexing the Atlantic cables, and has had complete success. We are able, through the kindness of Mr. Stearns, to reproduce some specimens of the records very recently obtained on the 1874 Atlantic cable duplexed by his system. The difficulty of preserving a balance with such a sensitive instrument as the Siphon Recorder must be evident, and the fact that the cable has now been working for more than two months, speaks well for the system.

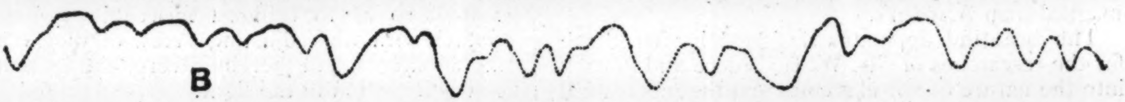
The speed which has been obtained experimentally is as high as 50 words per minute, that is 25 words each way. This latter is as great a speed as can be obtained when working in the ordinary way.

The following fac-simile copies of the Recorder slip will shew that the signals are as perfect as can be wished :—

Specimen of ordinary working at a speed of 25 words per minute, A.



Specimen of duplex working at a speed of 25 words per minute each way, B.



A NEW ELECTRIC MARVEL.

THE Dynamo-Induction Balance of Prof. Hughes, which will be brought before the Royal Society to-night, has been justly characterised by Prof. Stokes as perhaps the most remarkable scientific instrument of our time. It is an electric currents induction balance, just as Wheatstone's was a currents resistance balance, but of so sensitive a nature that by its means the physicist will be enabled to investigate the molecular structure of bodies, and thus to probe the recesses of matter by that subtle implement electricity. It is likely to give a great impulse to electric science, and, indeed, to research of all kinds, for there seems to be no branch of physics to which it will not prove useful. Already it has proved a wonderfully sensitive coin tell-tale or assayer, and an excellent sonometer for measuring the power of hearing. But it contains the capacity for becoming a magnetic thermometer, a stress-meter, a photo-meter (through the agency of selenium, or such-like substances), and, among other things, a delicate means of measuring not only the static capacity of condensers, but the resistance of liquids. We are compelled to defer a full account of it till our next.

THE SOIRÉE OF THE ROYAL SOCIETY.

THE *soirée* of the Royal Society is always the principal scientific festival of the year, and that recently held at Burlington House, on the invitation of the President, Mr. Spottiswoode, and the Fellows, was as brilliant as those of former years. Statesmen, foreign ministers, including the emissary of the Celestial Empire, generals, admirals, famous travellers, and distinguished men of science crowded the reception rooms, and inspected the various apparatus there displayed. There was no real important novelty exhibited; for all the chief instruments had been made public before. The interest centred most in Edison's loud-speaking telephone (*see* TELEGRAPHIC JOURNAL, April 1, 1879), which was operated in a small hall downstairs by Colonel Gouraud and Mr. C. P. Edison. In another room the exhausted tube and electric apparatus with which Mr. Crookes has produced so many startling and beautiful effects of molecular light (*see* TELEGRAPHIC JOURNAL, Jan. 1, and Mar. 1), also attracted much attention; the rotation of a small glass turbine in vacuo by a stream of molecules, and the splendid glows produced in phosphorescent substances when exposed to the negative discharge in a highly exhausted tube. Pieces of Becquerel's luminous sulphide of calcium shone with a bright blue-violet light when the discharge played upon them; and it is said that a surface of several square inches of this material is sufficient to faintly light a room when thus treated. Grains of diamond blazed with a yellowish-green glow-worm lustre; and the ruby kindled with a rich red effulgence. Whatever degree of colour the ruby possesses naturally, the tint emitted under the negative discharge appears always of the same fulness. It is curious also to note that South African diamonds though straw-coloured in ordinary light, give out a blue phosphorescence under the discharge; while diamonds from other localities shine with different hues, such as bright blue, apricot, pale blue, red, pale green, and orange. One large fluorescent diamond gives almost as much light as a candle when phosphorescing in a good vacuum. Perhaps Mr. Edison will get a hint here, and astonish the world with a ruby lamp, more magical than Aladdin's.

The beautiful apparatus designed by Mr. Stroh for the researches of Mr. W. H. Preece and himself into the nature of vowel sounds and the mechanical production of speech, were also much admired. In our issue for April 15, we gave some account of these instruments. One of the most novel of these was a small soft iron tongue, kept vibrating by means of an electro-magnet, which was made to utter the vowels o, ah, a, e, by simply shortening it to certain degrees. Very intricate and graceful curves were also drawn by the phonautograph, or speech recorder of Mr. Stroh. In the same room was exhibited the Telegraphic Pen of Mr. E. A. Cowper (*see* TELEGRAPHIC JOURNAL, March 1). Bright's electrical fire alarms, which, we hear, are about to be introduced into London (*see* TELEGRAPHIC JOURNAL, Feb. 15) and Tisley's small dynamo-magneto machine in which a stream of water is passed through the hollow armature to keep it cool. Dr. Settle, of Reading, also demonstrated the spiral path of the lines of force of a bar-magnet by means of a small suspended needle-magnet about $\frac{1}{8}$ of an inch in length; and Mr. Conrad W. Cooke presided over a model of Syke's Interlocking and Block System for Railway Signalling, and a signal wire compensator, whereby the position of a semaphore arm is protected from disturbance.

Various other appliances and productions were on view; sea-fowl eggs, brought home in the *Challenger* from the South Seas; water-colour drawings of the Alps, by Mr. George Barnard; photographs by Mayal; Japanese vases; drawings of the solar spectrum, executed by Captain Abney; spectroscopes by Mr. Hilyer; polarising crystals by Mr. Ladd; and a new automatic electric lamp, which burns equally well either horizontally or vertically, by Mr. Browning. There were a few sacred relics there also, preserved under glass: Roubilliac's original plaster cast of Newton's face, taken from his corpse, together with the manuscript of the "Principia"; and to the electrician, perhaps, more interesting still, the many and varied honours of Michael Faraday, with the original indenture between him and Mr. George Ribau, the bookbinder, lying over all.

EDISON'S ELECTRIC CANDLE.

MR. EDISON'S second invention patented in this country may now be seen on application at the Great Seal Patent Office. It is entitled, "Improvements in Lighting by Electricity." The letters patent bear date Nov. 7, 1878, and the final specification was filed on the 7th inst. by Edward Griffith Brewer, agent, Chancery Lane, on behalf of Thomas Alva Edison, of Menlo Park, State of New Jersey, U.S. As set forth by the patentee in the specification, the special feature of the invention relates to the candle for the diffusion of the electric light.

A thermal circuit regulator, which has been described in an earlier patent recently published, is attached at the bottom of the candle, and is so arranged that if the current becomes excessive, the regulator becomes heated, and consequently expands so as to bring a moveable spring into contact with the adjusting screw of the illuminating apparatus, and thereby diverts the current and lessens its action in the light.

Fig. 1 is a section of the candle, showing also the circuit connections.

Fig. 2 is an enlarged section of the candle detached, and fig. 3 is a perspective view of the candle portion X, which is in the form of a slightly tapering hollow cylinder, divided vertically, except at the upper end. By this arrangement he claims that uniformity and complete incandescence are secured as the electric current passes up one side and down the other. At the base of the cylinder, which is enlarged for the purpose, the electric conductors are connected. The electric current enters *n'*, passes by the wire *k*, to the candle X, up one side and down the other, there being clamps to connect the wires to the base of the split candle, thence by the circuit regulator to spring L and clamp to the other wire of the circuit.

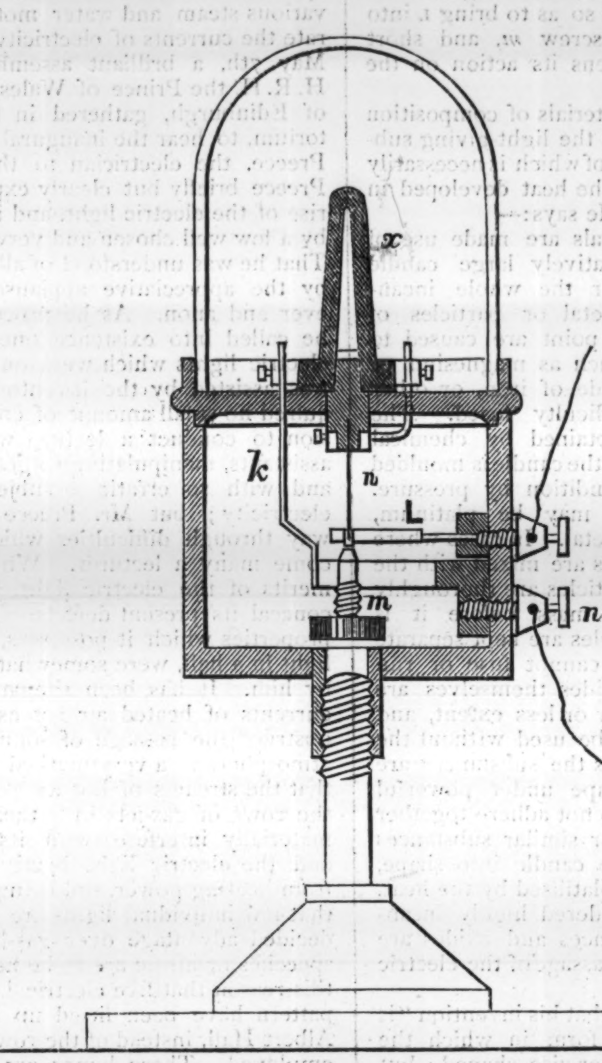


FIG. 1.

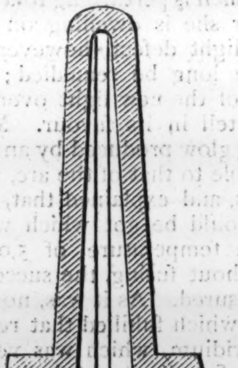


FIG. 2.

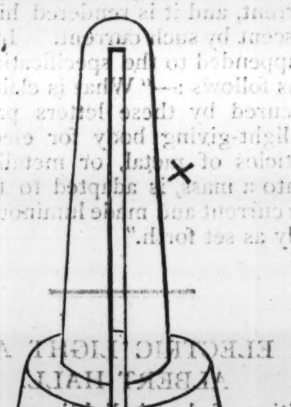


FIG. 3.

If the current is excessive, the regulator *u* becomes heated and expands so as to bring L into contact with the adjusting screw *m*, and short circuits the current and lessens its action on the light.

Mr. Edison specifies the materials of composition and method of manufacturing the light-giving substance, the essential condition of which is necessarily its power to resist fusion by the heat developed in the passage of the current. He says:—

"Metals or oxides of metals are made use of which produce in a comparatively large candle sufficient resistance to render the whole incandescent. Finely divided metal or particles of metal having a high melting point are caused to adhere by earthy materials, such as magnesium or zircon oxides or magnetic oxide of iron, or other substances that are with difficulty fused. The oxides of metals may be obtained by chemical precipitation or otherwise, and the candle is moulded either in a dry or moist condition by pressure. The fine particles of metal may be platinum, irridium, ruthinum, or other metal. In cases where these oxides or earthy materials are mixed with the fine metallic particles, such particles are thoroughly and uniformly mixed into a mass before it is moulded, and hence such particles are kept separate by the earthy material, and cannot fuse or run together, and the metallic oxides themselves are electric conductors to a greater or less extent, and hence may in some instances be used without the particles of metal. In all cases the substances are moulded and pressed into shape under powerful pressure, and if the particles do not adhere together sufficiently, sugar, tar, silica, or similar substances may be used in moulding the candle into shape, and these substances may be volatilised by the heat. The metallic particles are rendered highly incandescent, and the earthy substances and oxides are also rendered luminous by the passage of the electric current."

Finally, the patentee declares that his invention "is not limited to any particular form in which the candle may be moulded or otherwise shaped; but it relates to the materials employed in such candles, whereby the mass is adapted to the passage of the electric current, and it is rendered highly luminous or incandescent by such current." In the statement of claims appended to the specification Mr. Edison sets forth as follows:—"What is claimed as the invention secured by these letters patent is that a candle or light-giving body for electric lights, in which particles of metal, or metallic oxides, are moulded into a mass, is adapted to the passage of the electric current and made luminous by the same, substantially as set forth."

THE ELECTRIC LIGHT AT THE ALBERT HALL.

THE exhibition of electric lighting apparatus, which was held in the Albert Hall of Arts and Sciences during the 7th, 8th, 9th, and 10th of May, was, without a doubt, the most perfect of its kind ever held before. The spacious arena of the immense hall was set apart for the more delicate instruments and plant used for the production of the light, while space was reserved outside the building for the various steam and water motors required to generate the currents of electricity. On the evening of May 7th, a brilliant assembly, presided over by H. R. H. the Prince of Wales, assisted by the Duke of Edinburgh, gathered in the magnificent auditorium, to hear the inaugural lecture of Mr. W. H. Preece, the electrician to the Post Office. Mr. Preece briefly but clearly explained the origin and rise of the electric light, and illustrated his remarks by a few well chosen and very striking experiments. That he was understood of all present was apparent by the appreciative applause which greeted him ever and anon. As he proceeded in his remarks, he called into existence, one by one, the different electric lights which were on view, and in this he was assisted by the inventors themselves. It required no small amount of courage and self-possession to conduct a lecture with so many diverse assistants, manipulating so great a variety of lamps, and with so erratic a subject to deal with as electricity; but Mr. Preece skilfully piloted his way through difficulties which would have overcome many a lecturer. While enlarging on the merits of the electric light, he did not, however, conceal its present defects. The better acoustical properties which it possesses, as compared to gas-light in a hall, were somewhat strongly put forward by him. It has been shewn by Dr. Tyndall that currents of heated air act as a sound-screen and obstruct the passage of sound-waves through the atmosphere in a very marked manner. Hence it is that the streams of hot air perpetually rising from the rows of gas-jets in a theatre or concert-room, materially interfere with its acoustical qualities, and the electric light being almost entirely free from heating power, and being, moreover, so bright that few individual lights are needed, thus offers a decided advantage over gas-light, in places where speeches or music are to be heard. It is partly for this reason that five electric lamps of the Siemens pattern have been fitted up in the ceiling of the Albert Hall, instead of the rows of gas-jets formerly employed. These lamps are kept going for less than a half of the sum required to supply an equal illumination by gas, and the only drawback to their use is a certain hissing noise which they sometimes emit, and which is perturbing to a vocalist, especially when he or she is dwelling on the higher notes. This is a slight defect, however, which will, we believe, ere long be remedied; and the greater healthiness of the new light over the old should be allowed to tell in its favour. Mr. Preece pointed out that the glow produced by an incandescent wire was preferable to that of the arc, from its steadiness and softness, and explained that, if a metal or solid substance could be got which would stand being raised to a temperature of 5,000° Fah. by the current, without fusing, the success of this method would be assured. As it was, no substance had yet been found which fulfilled that requirement, except the metal iridium, which was very scarce and expensive. A fine display of the iridium incandescent light by the Anglo-American Electric Light Company exemplified these remarks. In conclusion, Mr. Preece alluded to the growing application of the electric light in lighthouses, ships, forts, and large workshops, and, while admitting the scope there was for its improvement, did not hazard an opinion as to its practicability for domestic purposes.

The Duke of Edinburgh expressed his opinion that for naval purposes, such as the avoidance of collision, or discovery of torpedo boats, as well as for light-house illumination, the electric light would be of great service.

The "illustrative exhibits" in the arena of the hall consisted of a great variety of electric machines: from the earlier forms of Saxton, Holmes, and the Alliance Company, to those of Wilde, Gramme, Siemens, Ladd, De Méritens, and Schuckert. There was here also a very fine Otto Silent Gas Engine, of 3½ H.-P., exhibited by Messrs. Crossley Brothers, and driving a Gramme machine and Werdermann lamp. There were also a large number of electric lamps, including the Regulators of Siemens, exhibited by Messrs. Siemens Bros., the Dubosq, Holmes, by the Trinity House, Chapman, Serrin-Jasper, and Suisse-Hallé, by the British Electric Light Co., the Rapieff, by the National Electric Light Corporation, the Serrin-Lontin, by Mr. Harding, agent for the Lontin Company, the Wallace, by the Anglo-American Light Co., the Sautter, by the War Office, the Pyramid, by Captain Brain, and the Krupp. A row of Jablochkoff candles were fitted up round one of the balconies of the hall, and lit with fine effect. The candles of Wilde, shown by the Electric Lighting Company, of De Méritens, of Rapieff, and of Mr. André were also shown. A Reynier incandescent lamp was exhibited by Mr. Crooks, and there were samples of the lamps of Werdermann and Higgins, together with the mining lamps of Trouvé and André. Messrs. Carré and Sautter, Lemonier and Co., and Siemens, showed specimens of their improved carbon electrodes.

Besides these principal exhibits, there was an interesting collection of photometric apparatus, including the photometers of Bunsen and Wheatstone. The Trinity House exposed a fine light-house dioptric apparatus, and Messrs. Siemens Bros. exhibited a holophote, or projector, of the electric light, a powerful moveable reflector, by which an electric beam can be directed to any part of the horizon or sky. This holophote will enable a ship to scour the sea for 2½ miles around, or a fort to explore the surrounding country by night for the enemy, or the sky for balloons. The War Office furnished a specimen of the Portable Electric Light apparatus, known as the "Steam Sapper" and Mr. Trouvé displayed his ingenious instruments for adapting the electric light to surgery, which have been described in the Telegraphic Journal for August 1, 1878. Nor must we forget a rich variety of elegant electric lamp posts, with opal and ground glass shades; and samples of different kinds of conducting wire and cable used in conveying the currents from the machines to the electrodes.

As nearly all these objects have already been fully described in our columns, we append the following list of the back numbers which illustrate them:—

The Gramme Machine, Jan. 15, Feb. 15, 1873; Sept. 15, 1874; Jan. 1, Aug. 15., Sept. 1., Oct. 1, 1875; Sept. 1, Dec. 15, 1876; Aug. 15, 1877; Dec. 15, 1878; Siemens' Machine, Nov. 15, Dec. 1, 1877; Schuckert's Machine, April 1, 1879; Jablochkoff's Candle, Jan. 1, 1879; Wilde's Candle, Jan. 1, 1879; Rapieff's Lamp, Aug. 15, Sept. 1, and Nov. 1, 1878, Feb. 1 and 15, 1879; Werdermann's Lamp, Nov. 15, 1878; Lontin's Machine and Lamp, May 1, 1879; the Wallace-Farmer Machine and Lamp, Nov. 1, 1878; the De Méritens' Machine, Oct. 1, 1878.

Steam motors, for driving dynamo-electric machines were also exhibited by Messrs. Robey & Co., Wallis & Stevens, Messrs. Ransomes, Sims & Head. That of the latter was illustrated in the Telegraphic Journal for March 15. The Otto Gas Engine appears in the present number.

Having now given a general review of the apparatus, it remains for us to treat in particular those exhibits which we have not already described in this Journal.

ON ELECTRIC LIGHTING.*

(First Paper.)

By Dr. JOHN HOPKINSON, F.R.S., M. Inst. M.E.

During the last year much has been written and much information communicated concerning the production of light from mechanical power by means of an electric current. The major portion of what has appeared has been either descriptive of particular machines for producing the current, and of lamps for manifesting a portion of its energy as light; or a statement of practical results connecting the light obtained with the power applied and the money expended in producing it.

Whilst fully appreciating the present value of such information, the author has felt that it did not tell all that was interesting or practically useful to know. It is desirable to know what the various machines can do with varied and known resistances in the circuit, and with varied speeds of rotation; and what amount of power is absorbed in each case. It is a question of interest, whether a machine intended for one light can or cannot produce two in the same circuit, and if not, why not; whether a machine, such as the Wallace-Farmer, intended as it is for many lights, will give economical results when used for one; and so on. It is clear that the attempt to examine all separate combinations of so many variables would be hopeless, and that the work must be systematised.

The mechanical energy communicated by the steam-engine or other motor is not immediately converted into the energy of heat, but is first converted into the energy of an electric current in a conducting circuit; of this a portion only becomes localised as heat between the carbons of the electric arc; and of this again a part only becomes sensible to the eye as light. The whole of what we need to know may be more easily ascertained and more shortly expressed if the inquiry is divided into two parts: (*a*) what current a machine will produce under various conditions of circuit, and at what expenditure of mechanical power; (*b*) having given the electric conditions under which the arc is placed, no matter how these conditions are produced, what light will be obtained therefrom. Parts of the subject have been treated more or less in this sense by Edlund (Pogg. Annal. 1867 and 1868), Houston and Thomson in America, Mascart (*Journal de Physique*, March, 1878), Trowbridge (*Philosophical Magazine*, March, 1879), Schwendler (Report on Electric Light Experiments), but not so completely that nothing remains to be done; nor does the author doubt that a very great deal of information is in the hands of makers of machines, which they have not thought it desirable to make known. The present communication is limited to an account of some experiments on the production of currents by a Siemens medium-sized machine: that is, the machine which is advertised to produce a light of 6,000 candles by an expenditure of 3½ horse-power.

---

* Paper read before Inst. of Mechanical Engineers.

All the machines for converting mechanical power into an electric current consist ultimately of a conducting wire moving in a magnetic field; and approximately the electromotive force of the machine will be proportional to the velocity with which the circuit moves through the field, and to the intensity of the field. In general the intensity of the field is not constant; and in such machines as the Siemens and ordinary Gramme machines it may be regarded as a function of the current passing. We must learn what this function is for the machine in question; or—which comes to exactly the same thing, and is better so long as the facts are merely the result of experiment—we must construct a curve in which the abscissæ represent currents passing, and the ordinates the electromotive force for a given speed of rotation. But the power of a current, that is its energy per second, is the product of the electromotive force and the intensity; this is in all cases less than the power required to drive the machine, and the ratio between the two may fairly be called the efficiency of the machine.

The object of the inquiry may perhaps be made clearer by an illustration. Consider the case of a pump forcing water through a pipe against friction; then the electric current corresponds to the water passing per second, and the electromotive force to the difference of pressure on the two sides of the pump; and just as the product of pressure and volume per second is power, so the product of electromotive force and current is power, which is directly comparable with the power expended in driving the machine or the pump, as the case may be. The peculiarity of the so-called dynamo-electro machine lies in this, that what corresponds to the difference of pressure (the electromotive force) depends directly on what corresponds to the volume passed (the current).

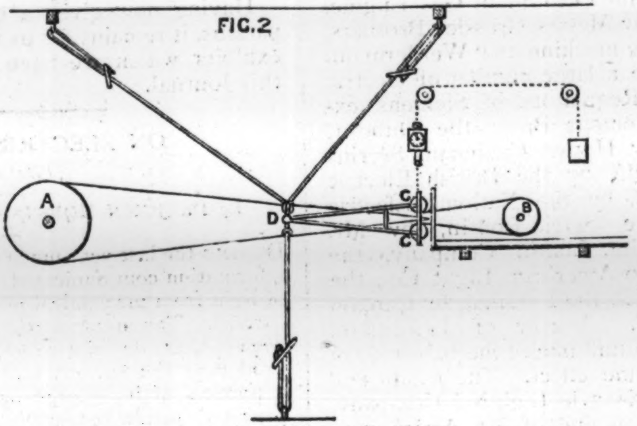


FIG.2

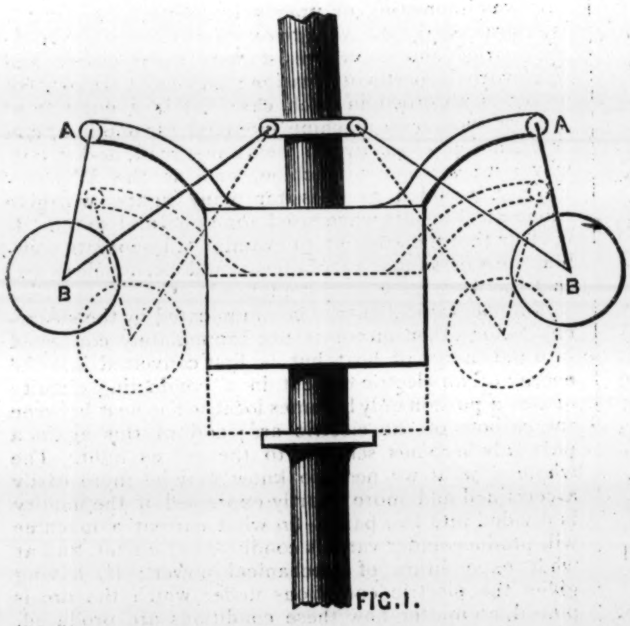


FIG.1.

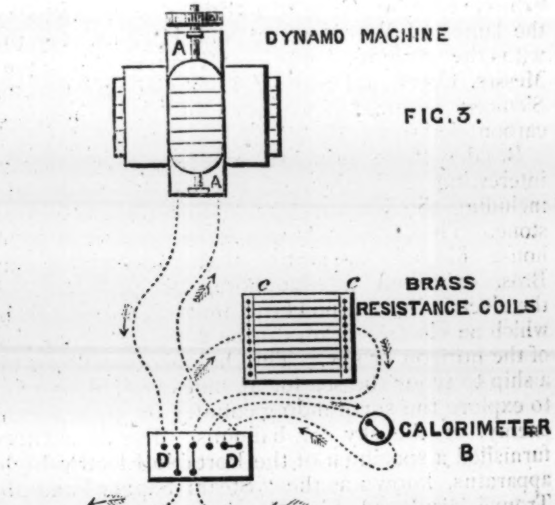


FIG.3.

Each experiment requires the determination of the speed, the driving power, the resistances in circuit, and the current passing: or of the difference of potential between the two ends of a known resistance of the circuit.

The apparatus employed by the author was arranged, not alone with an aim to accuracy, but in part to make use of such instruments as he happened to possess, or could easily construct, and in part with a view to ready erection and transport. Much more accurate results may be obtained by anyone who will arrange apparatus with a single aim to obtain the greatest accuracy possible. The author's apparatus will, however, be briefly described, that others may form their own opinion of the importance of the various sources of error.

The speed counter was that supplied with the machine.

Concerning the steam-engine nothing need be said save that its speed was maintained very constant by means of a governor shown in fig. 1, and specially arranged for great sensibility. By placing the joint A above the joint B, instead of below it as in Porter's governor, any degree of sensibility up to instability may be obtained. The speed was varied by means of a weight and a spring, attached to a lever on the throttle-valve spindle. The ungainly appearance of this governor could easily be remedied by anyone proposing to manufacture it.

The power is transmitted from the engine to a countershaft by means of a strap, and by a second strap from the countershaft to the pulley of the machine. On this second strap is the dynamometer shown in fig. 2.

This dynamometer has for some time been used by Messrs. Siemens, and was also used by Mr. Schwendler; its invention is due to Hefner von Alteneck. A is the driving pulley; B is the pulley of the electric machine; C C are a pair of loose pulleys between which the strap passes: these are carried in a double triangular frame, which can turn about a bar D. This bar might form part of a permanent structure; but in order to place the dynamometer readily on any strap, the bar was in this case provided with eyes at either end, and secured in position by six or eight ropes. This plan answers well, as there is very little stress on the bar. From the frame immediately above the pulleys a cord leads through a Salter spring balance over snatch-blocks to a back balance-weight; the tension of this cord is read on the spring balance. At first the spring-balance was omitted, and the weight at the end of the cord was observed; but the friction of the snatch-block pulleys was found objectionable. The pulley frame carries a pointer, which is adjusted to a fiducial mark when the line A B bisects the distance between the loose pulleys. Let W′ be the tension of the cord required to bring the pulley frame to its standard position when no work is being transmitted; W″ the tension which is required to bring the pointer back to the fiducial mark, when an observation is made; and let W=W′—W″. Let T′ T″ be the tension in the two parts of the strap; R_1 R_2 r the radii of the pulleys A, B, and C, plus half the thickness of the strap; C_1 C_2 the distances A C, C B; d the distance apart of the centres C C; a_1 a_2 the inclination of the two parts of the strap to the line A B. Then

$$(T' - T'')(\sin a_1 + \sin a_2) = W;$$

$$\text{and } \sin a_1 = \frac{R_1 + r - d}{C_1} + \frac{d}{2C_1}\left(\frac{R_1 + r - d}{C_1}\right)^2,$$

$$\sin a_2 = \frac{R_2 + r - d}{C_2} + \frac{d}{2C_2}\left(\frac{R_2 + r - d}{C_1}\right)^2,$$

very nearly.

The value of T′—T″ and the velocity of rotation of the machine being known, the power received is readily obtained, expressed in gram-centimetres per second. Multiplying by 981, the value of gravity in centimetres and seconds, the power is then expressed in ergs* per second, and is ready for comparison with the results of the electrical experiments.

As already stated, the dynamo-electric machine in the present case was a Siemens medium size; the armature coil has fifty-six divisions and the brushes are single, not divided, that is, each brush is in connection with one segment of the commutator at any instant.

The leading wire is 100 yards of Siemens No. 90, consisting of seven copper wires, insulated with tape and india-rubber, and having a diameter of about 9·6 mm.

The method of determining the current is shown in the diagram, Fig. 3. The current is conveyed from the machine A, through a set of coils of brass wire *c*, and in some cases through a resistance coil placed in a calorimeter, and so back to the machine, the connections being made through cups of mercury excavated in a piece of wood D. The current passing may be ascertained by the heating of the calorimeter, or by measuring the difference of potential at the extremities of the resistance *c*, all the resistances of the circuit being supposed known. This difference of potential could of course be very easily measured by means of a quadrant electrometer; but as the instrument had to be frequently removed, a galvanometer appeared more convenient. The two points to be measured are connected to the ends of a series of resistance coils *a b*. The galvanometer is placed in a second derived current, passing from junction *a b* through a single Daniell element, a set of high resistances for adjusting sensibility, a reversing key, the galvanometer, the reversing key again, and so to the other extremity of *b*. The electromotive force is ascertained by adjusting *b* so that the deflection of the galvanometer is *nil*.

The resistance coils *c* comprise ten coils of common brass wire, each wound round a couple of wooden uprights driven into a baseboard common to the set; each wire is about 60 metres long, and of No. 17 Birmingham wire-gauge, weighing about 14·6 grammes per metre. Each terminal is connected to a cup of mercury excavated in the baseboard, so that the coils can be placed in series or in parallel circuit at pleasure. The resistance of each coil being about 3 ohms, this set may be arranged to give resistances varying from 0·3 to 30 ohms.

The calorimeter is a Siemens pyrometer with the top scale removed; a resistance coil of uncovered German silver wire nearly 2 m. long, 1·5 mm. in diameter, and having a resistance of about ½ ohm, is suspended within it from an ebonite cover, which also carries a little brass stirrer; and the calorimeter is filled with water to a level determined by the mark of a scriber. It was of course necessary to know the capacity of the calorimeter for heat. It was filled with warm water up to the mark, and the coil placed in position; 120 grammes of water were then withdrawn, and the temperature of the calorimeter was observed to be 58·8°C.; after the lapse of one minute it was 58·3° C.; after a second minute 57·9° C.; 120 grammes of cold water, temperature 13·3 C., were then suddenly introduced through a hole in the ebonite cover, and it was found that, two minutes after the reading of 57·9° C., the temperature was 50·0° C.; hence we may infer that the capacity of the calorimeter is equal to that of 740 grammes of water. Two similar experiments at lower temperatures gave respectively the numbers 749 and 750. Estimating the capacity from the weight of the copper cylinder supplied with the pyrometer, it should be 747, to which must be added the capacity of the German silver wire and stirrer. Taking everything into consideration, 750 grammes may be assumed as the most probable result.

---

* The dyne is the force which will in one second impart to one gram a velocity of one centimetre per second, and an erg is the work done by a dyne working through a centimetre; a horse-power may be taken as three-quarters of an ergten per second, an ergten being 1010 ergs. See Report of Brit. Assoc., 1873, and Everett "On the C. G. S. System of Units," published by the Physical Society.

The resistance coils, marked *a b* in the diagram, Fig. 3, are of German silver, made by Messrs. Elliott Brothers, they are on the binary scale from ⅛ ohm to 1024 ohms. Separate coils were used, instead of a regular resistance box, because they were more readily applicable to any other purpose for which they might be required; and the binary scale was adopted, because the coils could at once be used as conductivity coils in parallel circuit also on the binary scale. Each coil as supplied terminated in two stout copper legs; these were fitted with cups of india-rubber tubing for mercury, whereby any connections whatever could readily be made. This arrangement though rude was very convenient, and perhaps even safer from error than a box with brass plugs to make the connections. By a slight alteration of the connections the whole was instantly available as a Wheatstone's bridge to determine resistances.

The battery was a single element of Daniell's battery, in which the sulphate of zinc solution floats on the sulphate of copper; its electromotive force is assumed to be 9/8 volt.

The resistances added in the battery circuit are pencil lines on glass, such as are described in the *Philosophical Magazine* of February last. Three were used, giving a range of sensibility approximately in the proportions 1, 25, 170, 700; they are very useful in adjusting the resistance *b* so as to give no deflection of the galvanometer.

The reversing key belongs to Sir W. Thomson's electrometer, and is quite suitable when high resistances and *nil* methods are used.

The galvanometer is far more sensitive than necessary, and has a resistance of 7000 ohms.

(*To be continued.*)

Notes.

THE electric-light light has superseded gas in the Place d'Armes at Lille. A fancy light placed over the town clock also displays the three national colours by means of chemical matter introduced into the arc.

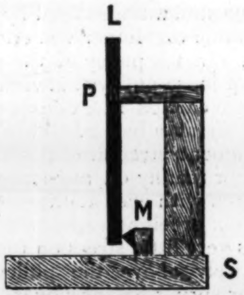
The New Eddystone lighthouse will be a granite tower rising 140 feet above the high water level of the ocean. A powerful electric light will be employed, with the use of a spare machine in thick fogs. The light will be placed about 120 feet above the water, and will command a range of 18 miles. It will revolve every minute, and its intensity will equal 180,000 standard candles.

Mr. EDISON declares that he has now made his electric light one-third the cost of gas. The Menlo Park machine shop is now regularly lit by 16 lamps, each giving a light equal to three gas gets. The lamp consists of a platinum coil in a glass bulb, about the size of an orange, and will cost about five shillings. The regulator is only required for turning up the light. He has, now, he says, contrived a machine which gives more electricity to the horse-power than either the Wallace or Gramme machines; and hopes to light up all the houses in Menlo Park in a few weeks. His new 2½ horse-power machine feeds five Wallace-Farmer lamps.

The high importance of the electric light as a preventative of collisions at sea, was strongly advocated by Dr. C. W. Siemens in his examination before the Parliamentary Committee. But although it was solely due to the electric light carried by the *Faraday* that a most disastrous and fatal accident was prevented, the Board of Trade objected that the *Faraday* had committed an illegal act in exhibiting an electric light at sea. There is an objection to the employment of the new illuminant, on the ground that it may give rise to serious mistakes, the light carried by a ship being taken for that of a lighthouse. Through this apprehension the Board of Trade have issued regulations prohibiting the use of the electric light for ships' signals. But for these restrictions, it is said that all the Atlantic ships would use the light for signalling purposes.

SIR JOSEPH BAZALGETTE, the engineer of the Metropolitan Board of Works, has reported on the electric lighting of the Embankment. The cost of the light is 5·78d. per hour, and to produce an equal light by gas would cost, in opal globes, 2d. per hour, and in frosted globes, 3·50d. per hour. He considers the electric light to have established itself; but to possess defects at present for general illumination.

THE PENDULUM MICROPHONE.—A very simple and efficient microphone is made by suspending a lever or pendulum of carbon, marked L in the figure, from an upright support S, by a pivot P, so that its lower end rests gently against a sharp contact piece of carbon M, fixed to the base of the frame. The point of meeting or joint is the microphonic contact, and this form is an excellent illustration of the peculiar nature of the thing called microphone. If left free to vibrate of itself the pendulum would only do so three or four times in a second; and since it is the property of every pendulum to have an invariable period depending on its length, &c., the microphonic action clearly cannot consist in simply making the rod swing of its own accord, for if we ring the note A (equivalent to 435 vibrations a second) this microphone will distinctly transmit it, and, indeed, notes and chords of all pitches and timbres.



THE TELEPHONE is about to be introduced into Sheffield on the American Exchange principle.

THE suit brought by the Bell Telephone Company, and Morgan Brown *v.* Jackson, will, we believe, be heard on June 20th.

IN our report of the proceedings of the Physical Society will be found some interesting observations on the theory of the Bell telephone.

ANIMAL ELECTRICITY.—In a remarkable lecture delivered before the Medical Society of Zurich on February 2nd, 1878, and published in our contemporary, *Nature*, for April 17th, Dr. L. Herman summarises that "the whole of the electrical phenomena of muscle and nerve may be readily deduced from a very few simple proportions. Irritable protoplasm responds both to destructive and to exciting influences by an electro-motive sign. The altered substance takes on a negative potential with respect to the unaltered. This, together with the doctrines of internal transverse polarisation, and of the polarisational increment of excitation, appears fully competent to explain all the facts hitherto observed."

Professor Bell on Induction.—Touching the reference made to the twisted wire plan for overcoming induction in connection with Professor Hughes' Induction Compensator, Professor Bell writes to correct the statement that the same method had also been "lately" patented by him. He says, "I presume from this that your information has been derived from a letter originally published by Mr. Brooks in the *Philadelphia Times*, charging me with having obtained his idea through the medium of a mutual friend, and with having subsequently patented the invention as my own, in England. In my reply to this letter, which has not been as extensively copied as the original charge, I showed that Mr. Brooks laboured under a misapprehension as to the date of my patent. Instead of this being November 20th, 1878, as would be inferred from Mr. Brook's statements, the actual date is November 20th, 1877. I intend publishing shortly to the American Academy of Arts and Sciences a paper upon Induction, giving the results of my experiments in England, a copy of which I will forward you as soon as published." Professor Bell also states his intention of testing Professor Hughes' beautiful induction compensator on the American Exchange telephone lines.

The Eastern Telegraph Company's officers at Porthcurno amuse the tedium of their solitude by negro minstrelsy, and recently gave a spirited "Ethiopian Entertainment," in Mr. Ash's lecture hall. The gorgeous Southern scenery was painted by a member of the staff; and elegantly illustrated the moving episodes enacted in front of them. Country people came from ten miles round, and the hall was crowded to excess.

We regret to say that Mr. R. S. Brough, of the Indian Telegraph Service has just died of cholera, after very brief and sudden illness.

We are also sorry to record the death of Mr. Adams, the well-known assistant of Mr. T. A. Edison in this country. Mr. Adams who has been ailing for some time past, died on Sunday, May 4th, at Paris. He was by birth an Englishman; but emigrated to the United States, and became associated with Mr. Edison who is ever ready to prefer ability in his employment whenever it shows itself.

Professor Volpicelli, the Italian electrician, died at Rome on April 14th.

Herr Wolff, the founder of Wolff's Telegraphic Bureau in Germany, is dead.

The physical laboratory of King's College is to be named after Wheatstone.

A cable manufactured by Mr. Henley has been sent out to Russia, in order to be laid across the Caspian Sea.

The acquisition by the Government of the undertaking of the United Kingdom Telegraph Company having been recently brought before Parliament, and a memorial presented to it by Mr. J. M. Gadd, alleging frauds against the directors of that company, these gentlemen have published a declaration refuting the assertions of the memorial in question.

Mr. Willoughby Smith's recent paper to the Society of Telegraph Engineers on the "working of Submarine Cables," has been separately published as a monograph, and will form an interesting contribution to the history of the subject.

Mr. Charles Stewart, M.A., has been awarded a silver medal by the Academie Nationale of Paris, for his treatises on "International Correspondence, by means of numbers, an easy method whereby people of different nations may readily communicate with each other," and "how to learn the Morse Alphabet in half an hour." These books are published by Messrs. E. Marlborough and Co.

The current from a dynamo-electric machine of Mr. Field was recently applied to telegraphy in the working of fifteen large circuits.

The American Cable Company propose to lay a cable from New York to Flores, an island of the Azores, the conductor weighing 500 lbs. per knot; a cable from Flores to France, England an Holland; a cable from Flores to Fayal (Azores), San Miguel and Lisbon. These will comprise 7,300 miles of core. The cable steamer is estimated to cost £70,000.

The s.s. *Patrick Stuart*, a new repairing steamer, named after Lieut-Col. Patrick Stuart, the projector of six Persian telegraph lines, has arrived in the Thames from the Forth, where she was built. Her tonnage is 1,930, she is 235 feet long by 30 feet 6 inches wide, and 13 feet 6 inches deep. Her engines are compound and 11 nominal H.-P. She has a speed of 10 knots per hour. Her hold is fitted with four cable tanks of 24 and 28 feet in diameter, capable of holding 170 miles of Persian Gulf cable, and the iron cores of these are made to serve in fresh water tanks.

The *Operator* informs us that the Western Union Telegraph Company has laid pneumatic tubes to connect its main office with the *Herald*, *Times*, *Tribune*, *World*, *Sun*, and *Staats Zeitung* newspaper offices in New York, so as to ensure a prompter delivery of despatches.

Proceedings of Societies.

PHYSICAL SOCIETY.—April 26th, 1879.

Prof. W. G. Adams, in the Chair.

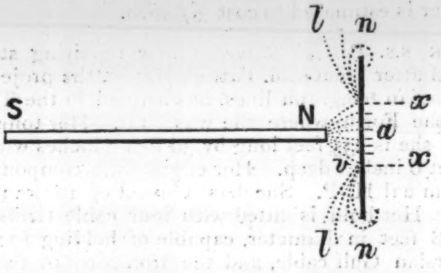
Mr. C. V. Boys gave an account of some experiments made by Dr. Guthrie and himself on the subject of Arago's rotation. The experiments were begun with a view to determine if the drag on a copper disc when a magnet is made to revolve beneath it, or on the magnet if the disc is made to revolve above it, could be made use of for determining the velocity of running-machinery.

They made the magnet revolve and obtained the angle of deflection of a disc suspended by a torsion thread (the hair spring of a watch). They found, as Snow, Harris, and others found before, that other things being equal, the drag is directly proportional to the speed, so that if the torsion of the thread could be relied on, and the strength of the magnet did not change, a perfect velocimeter could be constructed. They consider that this method is better than observing the deflection of a magnet over a revolving disc, as in this case they are limited to less than a right angle, and changes in the absolute magnetism of the earth would affect the results.

They also determined the effect of change of distance, thickness, diameter, and nature of the disc, &c., their results agreeing with those of former experimenters. They observed that the effect of concentric circular cuts was far greater than that of even many radial cuts; and that when radial sectors were entirely separated from each other the effect was much less than when these were united at the centre.

They then experimented on liquids by suspending a sphere or cylinder of the liquid between the poles of a revolving electro-magnet, and succeeded in getting a decided and measurable effect. The importance of this is very great, for they have thus a means of determining the conductivity of liquid electrolytes by currents induced in the liquid without the use of electrodes and without polarisation.

Dr. **Guthrie** states that as the push on the liquid is directly proportional to the current quantity, they hope to measure the conductiveness of liquids and connect these to the conductivity of solids through the intervention of mercury. Dr. Guthrie stated that a conducting jelly made by dissolving gelatine in anhydrous glycerine at 100° was being prepared for trial.



Prof. Sylvanus Thomson then communicated five laboratory notes from University College, Bristol. The first relates to the source of sound in the Bell telephone receiver. Two theories are now being discussed as to this effect, the molar theory regards the motion of the diaphragm in mass as the source of sound, the molecular theory finds it in the molecular motions of the magnetic core of the instrument. Prof. Thomson applied his method of getting magnetic curves with iron filings dusted on gummed glass to this problem. He found that when no currents passed in the telephone, the magnetic lines springing from the pole of the magnet are gathered together on the diaphragm opposite over a central region (*a* in the figure) which is magnetised lamellarly, or like a magnetic shell. The rim of the plate beyond this region is, however, magnetised radially, the external poles *n n* being of the same name as the near pole of the magnet, and between these two zones there is a neutral circle *x x*. It was remarkable, too, that the lines of force *l l*, touching the plate, were bent back around this circle forming a kind of valley *v*. When the current passed in the coil, in a direction so as to reinforce the magnetism, the lines are gathered more closely on the central region of the plate. If the current diminishes the magnetism, the lines are, on the other hand, repelled from the plate. The neutral ring is also altered. In the first case it shrinks in size, in the second it expands. A small thick disc is wholly magnetised lamellarly; a disc entirely magnetised radially becomes slightly conical in shape. In the actual telephone the disc is flat at the middle and conical at the edges. As the neutral ring shifts, the diaphragm will assume new nodal lines. Dr. Thomson concludes that the molecular theory is not, therefore, necessary to account for the speech of the telephone, although it may assist. As confirming this view, he found that with iron rings round a cardboard diaphragm and an iron centre-piece the enunciation was good though the timbre was altered; whereas, with radial pieces of iron on the cardboard, the timbre was good but the enunciation bad. In reply to Prof. Adams, Dr. Thomson said that the stronger the magnet the smaller the lamellarly magnetised space became, and that with a thicker disc the neutral ring was not so well marked.

Dr. **Lodge** suggested that the best place for the coil would be in the valley over the neutral ring which was in an unstable condition. It is also worthy of remark that the lines curve round the edge of the disc and project beyond the centre region *a*.

Dr. **Thomson** next wrote on a saw blade with a magnet, and dusted iron filings on it which arranged themselves so as to trace the writing. This is usually shown on a steel plate, but a saw retains the virtue for six or eight months. A modification of this experiment, due to himself, consisted in writing on the blade with one pole of a powerful battery, the other pole being connected to the end of the blade.

The third "note" recommended the use of fine steel fibres, got by breaking iron gauze of 32 meshes to the inch, instead of iron filings for exhibiting magnetic lines. The fourth note showed that the lines of force got by filings fixed on cards are magnetic, that of a bar magnet acting as a magnet. The fifth note explained that solid magnetic "figures" could be got by coating iron filings in shellac to make them light, and floating them in water; or by mixing filings in a soft paste of plaster of Paris, which could be cut into sections on hardening.

General Science.

ENGINES FOR WORKING ELECTRIC LIGHT MACHINES.

V.

The Otto Silent Gas Engine.

The first practical gas engine was, it is believed, introduced by M. Lenoir, of Paris, now nearly twenty years ago. In this engine the ignition of the explosive mixture of gas and air in the cylinder was effected by the passage of an electric spark, obtained from an induction coil worked by a battery. This arrangement, although effective, had many manifest inconveniences, and M. Hugon and others improved upon the idea by effecting the ignition by means of a small gas flare placed opposite a slight aperture in the cylinder, which was opened and closed by a valve. This device has been adopted in all the engines subsequently invented, and answers the purpose most effectually.

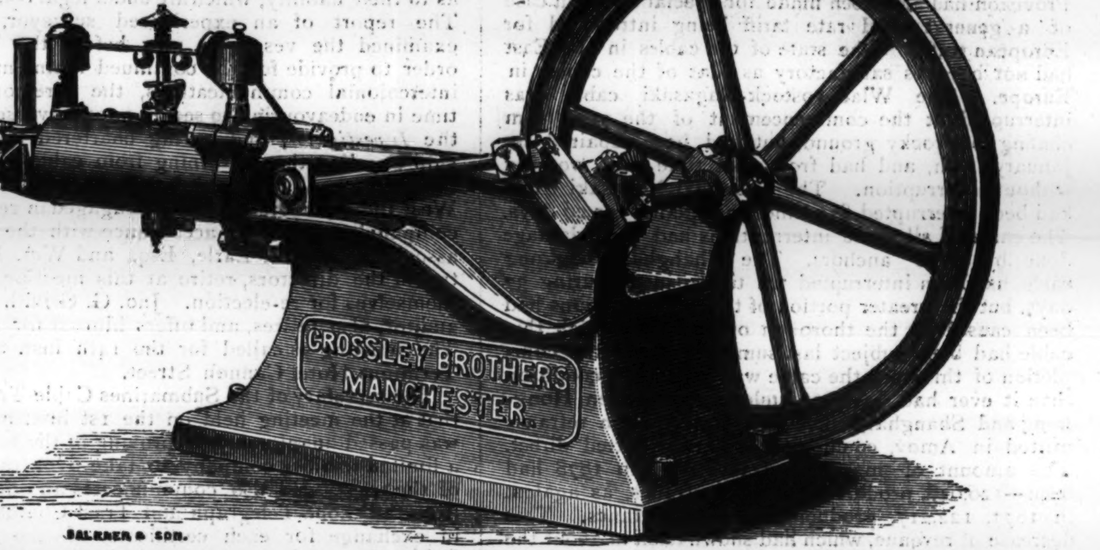
The progress of the electric light has given an impetus to the manufacture of gas engines, and at the present time a large number are employed for the purpose of driving dynamo-electric machines.

The general appearance of the Otto and Lanjen gas engine, as manufactured by Messrs. Crossley Brothers of Manchester, is shown by the cut on the following page.

The principle of combustion in these gas engines is entirely new. In them an explosion does not take place in the ordinary meaning of the term. A small part only of the charge is combustible, which on ignition serves to expand the remainder, thus avoiding shock and effecting great economy. The engines have also the peculiarity of igniting their charges at the *beginning* of the stroke, leaving *the whole* of the stroke for effective expansion of the gases, instead of merely a fraction as in obsolete constructions.

Every part of these engines is now made to gauge, and is therefore easily replaced. The wearing portions are also of the simplest and most inexpensive patterns; for instance, the working barrel of the cylinder itself can be supplied for about 1½ per cent. on the first cost of the engine, and being strictly to gauge, can be put in with great facility in a few hours.

By this system the engine may be kept permanently almost equal to new for a certain annual expenditure.



The pistons are of great length—of which the peculiar construction of the engine readily admits, and being also as light as possible, ride on the oil with the least degree of wear.

The slides valves keep in excellent condition with proper care; but, as far as possible, to prevent risk of stoppage even from neglect, they are supplied in duplicate with each engine without extra charge.

These engines will run with extreme smoothness and regularity of speed, and have very few working parts. They possess the great and sometimes indispensable advantage, as compared with steam engines, of starting at full power at once on the gas being lit, and, requiring no boiler, they avoid all the dangerous and pecuniary risks, annoyances, expensive repairs and attendance which a boiler frequently entails. The cost of a chimney, the nuisance of smoke, coal, ashes, and water must also be considered when a boiler is used. Where work is intermittent, trouble with a steam boiler and engine is at its maximum, but with a gas engine the reverse is the case.

The smallest engine capable of driving a Gramme "A" machine, is one 3½ H.-P. *nominal*, or 5¼ H.-P. *indicated*. The 8 H.-P. *nominal* will *indicate* 14 H.-P. These will drive 3 Gramme "A" machines and 2 Siemens "A" machines. The gas consumed by these engines per *indicated* H.-P. is from 21 to 23 cubic feet, the engine running at 160 revolutions per minute.

City Notes.

Old Broad Street, May 12th, 1879.

GREAT NORTHERN TELEGRAPH COMPANY.—At the annual general meeting of this company held at Copenhagen, on the 16th of April, 1879, F. Zahle, Esq., presided. The chairman, C. F. Tietgen, Esq., in his opening remarks, referred to the depressed state of trade which still continued, and which would naturally affect an undertaking like that of the company; nevertheless, it was satisfactory that the result of the year's working had been such that the revenue had been about the same as in the previous year, and that, notwithstanding a considerable amount had been credited to reserve, the directors were able to propose the payment of the same dividend as for the previous year. He then reported upon the company's business as follows:—The state of the cables in Europe had generally been satisfactory during the year 1878. At the beginning of the year, the cable between Denmark and France had been interrupted, an interruption which eventually proved to have been caused by damage done by anchors, but the repairs had been effected on the 5th March, and during the remainder of the year the cable had been working uninterruptedly. The cable between Finland and the Aland Isles had been interrupted from January 23rd to May 17th, the damage having been caused by chafing on the rocks. The cable between Denmark and Norway had been subject to an interruption, also caused by chafing on rocky bottom, but the interruption had only lasted from 2nd to 17th June. None of these interruptions had, however, caused any considerable loss to the company. According to the statistical tables there had been transmitted on the lines in Europe, during the year 1878—770,352 single telegrams, producing a revenue of 2,410,454 francs. Against, in 1877, 739,146 single telegrams, producing a revenue of 2,379,202 francs, which showed a slight increase, mainly due to the traffic on the Franco-Danish Cable, which had been much occupied during the Paris Exhibition, whilst the traffic on the other lines had suffered from the depressed state of trade.

The former agreement with the Post Office, after having been in force for seven years, had expired in September last. After some negotiations, heads of a new agreement had been drawn up on the 15th November, and these had subsequently been approved by the Treasury. The new agreement, which would remain in force until the year 1903, contained terms somewhat more onerous than the former contract; but, on the other hand, not only would the company retain the special land-lines hitherto worked by them between Aberdeen, Newcastle and London, but an additional wire from London to Newcastle had been placed at its disposal, thus duplicating that important section of the company's circuit, and this would much contribute towards an increase in the speed of transmission. Provision had also been made for special terms in case of a general word rate tariff being introduced for European traffic. The state of the cables in the East had not been as satisfactory as that of the cables in Europe. The Wladiwostock-Nagasaki cable was interrupted at the commencement of the year from chafing on rocky ground, but had been repaired on January 13th, and had from that time been working without interruption. The Shanghai-Nagasaki cable had been interrupted five times, altogether for 26 days. The cause of all these interruptions had been damage done by ships' anchors. The Shahghai-Hongkong cable had been interrupted ten times, in all during 37 days, but the greater portion of these interruptions had been caused by the thorough overhaul to which this cable had been subject last summer. After the completion of this work the cable was in a better condition than it ever had been, and telegrams between Hongkong and Shanghai, which had formerly been retransmitted in Amoy, could now be transmitted direct. The amount of messages transmitted in 1878 had been—126,048, producing 2,677,362 francs, as against in 1877, 122,217, producing 2,780,819 francs. This decrease of revenue, which had shown itself in about the same proportion with regard to the local traffic between the ports in China and Japan, as to the European traffic, was attributable, not only to the frequent interruptions of the cables, but also to the stagnation of trade. The accounts having been passed, the retiring director, C. F. Tietgen, Esq., was re-elected, as likewise were Admiral Bille and A. Berner, Esq., as the shareholders' auditors.

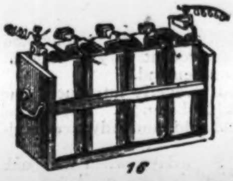
WEST INDIA AND PANAMA TELEGRAPH COMPANY.—The directors submit the accounts for the six months ending 31st December, 1878. The amount to credit of revenue is £37,052 12s. 9d., and the expenses have been £24,449 9s. 4d., leaving a balance of £12,603 3s. 5d., which, with the balance £3,391 7s. 6d. brought from last account, makes an available total of £15,994 10s. 11d., with which it is proposed to deal as follows:—First preference shares, half-year's dividend to 31st December, 1878, at 6 per cent. per annum £10,368 18s; second preference shares, half-year's dividend to 31st December, 1878, at 6 per cent. per annum £1,400 14s.; Reserve account £2,000. Balance to current half-year's account £2,224 18s. 11d. The expenses over which the directors can exercise control exhibit a small reduction, but the item of repairs to cables on account of accidents has been exceptionally heavy amounting to £3,199 16s. 3d. in excess of the corresponding half. This added to the additional expense of the ship amounts to £5,306 5s. 6d., in excess of the corresponding half-year, and precludes the directors from recommending any dividend upon the ordinary shares. During the half-year the Legislature of Jamaica, recognising the necessity of an increase to the company's revenue, granted a subsidy of £2,000 per annum for 10 years, commencing on the 1st October, 1878, and a quarter's payment of this subsidy is dealt with in the accounts. The board take this opportunity of expressing their sincere thanks to the colony for this much needed addition to the resources at their disposal, and for the appreciation evinced by this grant of the value of the company's services and the importance of securing their continuance. The directors regret to report that an accident occurred to the company's repairing ship *Investigator* on the 8th January last, owing to which she has been completely disabled. While steaming out of St. Thomas Harbour on her way to repair a cable, the port boiler exploded, causing the death of two of the crew and very serious damage to the vessel. A claim has been made upon the underwriters for the amount of insurance, but questions have been raised as to their liability, which are under legal consideration. The report of an experienced surveyor, who has examined the vessel, is now before the board. In order to provide for the continued maintenance of the intercolonial communications, the directors lost no time in endeavouring to secure another vessel to replace the *Investigator*, and having chartered the telegraph ship *Caroline*, then returning from cable repairs in the Mediterranean, she proceeded as soon as possible to the West Indies, where she is now engaged in repairing the company's cables. In accordance with the articles of association, C. W. Earle, Esq., and Wm. Ford, Esq., two of the directors, retire at this meeting, and offer themselves for re-election. Jno. G. Griffiths, Esq., the auditor, also retires, and offers himself for re-election. The meeting is called for the 14th inst. at the City Terminus Hotel Cannon Street.

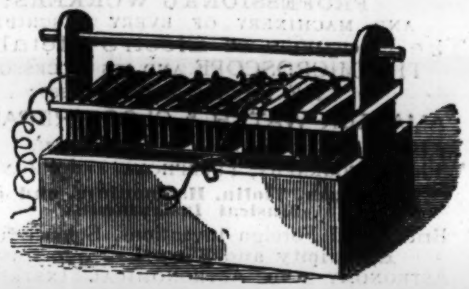
The secretary of the Submarines Cable Trust notifies that at the meeting held on the 1st inst. a resolution was passed unanimously approving of the formation of a limited liability company to take over the property of the trust. He also communicates an offer received from the Globe Telegraph and Trust Company to give in exchange for each certificate of the Submarine Cables Trust, after the coupon due last month is detached, five fully paid £10 preference shares and sixty fully paid £10 ordinary shares of the Globe Company.

The following are the latest quotations of telegraphs:—Anglo-American, Limited, 55¼-55¾; Ditto, Preferred, 85-86; Ditto, Deferred, 27-27½; Black Sea, Limited, —; Brazilian Submarine, Limited, 6⅝-6⅞; Cuba, Limited, 8-8½; Cuba, Limited, 10 per cent. Preference, 15½-16½; Direct Spanish, Limited, 1¾-2¼; Direct Spanish, 10 per cent. Preference, 10¼-10¾; Direct United States Cable, Limited, 1877, 10¾-11; Eastern, Limited, 7⅜-7⅞; Eastern, 6 per cent. Debentures repayable October, 1883, 104-107; Eastern 5 per cent. Debentures repayable August, 1878, 101-104; Eastern, 6 per cent. Preference, 11⅞-12⅛; Eastern Extension, Australasian and China Limited, 7½-7¾; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 108-110; German Union Telegraph and Trust, 7¾-8¼; Globe Telegraph and Trust, Limited, 4¾-5; Globe, 6 per cent. Preference, 10¾-11; Great Northern, 8¼-8½; Indo-European, Limited, 20½-21½; Mediterranean Extension, Limited, 2½-3; Mediterranean Extension, 8 per cent. Preference, 9¼-9¾; Reuter's, Limited 9½-10½; Submarine, 220-230; Submarine Scrip, 1¾-2; West Coast of America, Limited, 1¼-1¾; West India and Panama, Limited, 1⅜-1⅝; Ditto, 6 per cent. First Preference 8½-9; Ditto, ditto, Second Preference, 7¾-8¼; Western and Brazilian, Limited, 3⅝-4; Ditto, 6 per cent. Debentures "A," 95-99, Ditto, ditto, ditto, "B," 88-93; Western Union of U.S. 7 per cent., 1 Mortgage (Building) Bonds, 111-114; Ditto, 6 per cent. Sterling Bonds, 102-104; Telegraph Construction and Maintenance, Limited, 30-30½; Ditto, 6 per cent. Bonds, 107-109; Ditto, Second Bonus Trust Certificates, 2⅝-2⅞; India Rubber Co., 10½-11.

ELECTRIC LIGHT APPARATUS,

FOR EXPERIMENTS, &c.





No. 1 Set—Price £5.—This Apparatus consists of a self-regulating Electric Lamp, with silvered copper reflector; a powerful Galvanic Battery of 10 cells, with sufficient acids, &c., to work it several times; and all the necessary connections and conducting wires.

No. 2 Set—Price £10.—This Set is similar to No. 1, but the battery consists of 30 cells, and is capable of lighting up brilliantly a moderate sized shop or room.

No. 3 Set—Price £20.—This set is similar to the preceding, but the battery consists of 50 large sized cells, and the illuminating power is much greater.

APPARATUS FOR USE WITH THE ELECTRIC LIGHT.

Batteries, Carbons, Conducting Wires, Regulators, &c.

Agents for HICKLEY'S PATENT TELEPHONES, price £2 10s. per pair.

PRICE LISTS of SCIENTIFIC APPARATUS and CHEMICALS, Post Free 3d. each.

SPECIAL QUOTATIONS TO THE TRADE AND LARGE CONSUMERS.

M. JACKSON & CO.

(J. ORME & H. M. CAPNER.)

65, BARBICAN, LONDON.

ZANNI & BRIDGER,

MAGNETIC AND ELECTRIC TELEGRAPH WORKS,

1, JAMES STREET, OLD STREET, LONDON, E.C.

Bellpull for Block System.

Magneto-Electric Bell Pulls, entirely dispensing with the use of battery; very useful for *Private Houses* for ringing from *House to Stable*; for *Ship's Cabin*; also made larger to ring gongs for Mines, &c. Used with great success with the *Telephone*.

Magneto and Electric Alphabetical Dial Instrument.

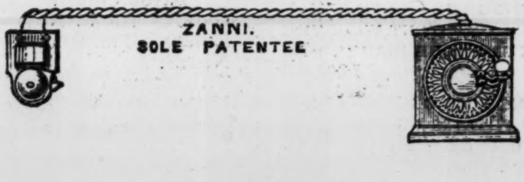
Patent Morse Instrument to work without Battery.

Batteries and all kinds of Electric Bells, Buttons, Indicating Tablets, with the latest Improvements.

CONSULTING ELECTRICIAN—G. ZANNI.

Liberal Discount to Trade.

Gong for Block System.



DESIGN AND WORK:

AN ILLUSTRATED JOURNAL OF INVENTIONS, MANUFACTURES, SCIENCE & ART.

Office: 41, Tavistock St., Covent Garden, London, W.C.

This Journal is devoted to the Advancement of the Exact Sciences, to
CHEMISTRY in the Class and the Laboratory,
To the Use of
TOOLS in the WORKSHOPS of AMATEUR and PROFESSIONAL WORKERS;
AND MACHINERY OF EVERY DESCRIPTION.
The Progress of Electro-Metallurgy;
THE MICROSCOPE AND ITS ACCESSORIES;
THE LATHE and its Uses;
AMATEUR WATCH & CLOCK REPAIRING.
Physical Science in General,
With PHOTOGRAPHY, TELEPHONY, and PHONOGRAPHY.
The Organ, Violin, Harmonium, and other Musical Instruments.
British and Foreign Inventions, Science and Art.
Electricity and Electrical Apparatus.
ASTRONOMY AND ASTRONOMICAL INSTRUMENTS.
Intercommunication between Readers on all Subjects of Genuine Interest, &c., &c.

Weekly, 2d.; by post, 2½d. Monthly parts, 9d., and by post, 1s. Quarterly subscription, post free, 2s. 9d.

ELECTRICAL, SCIENTIFIC, AND PHOTOGRAPHIC APPARATUS

FOR AMATEURS AND THE TRADE.

Electric Bells, Indicators, and Automatic Switches. Microphones from 1s. 6d.
Indication Coils, Lamps and Batteries, Magnets, Wires, Carbons, Terminals, &c. Illustrated Catalogue, one stamp.
Most Sensitive Dry Plates, Paper and Chemicals. Photographic List free. Repairs and Alterations to Instruments.

DALE & CRAMPTON,
Manufacturing Electricians,
4, LITTLE BRITAIN, LONDON, E.C.

THE LANCASTER ELECTRIC LAMP, devised by W. J. LANCASTER, F.C.S., F.R.A.S., &c., in three sizes. No. 1, to burn 3 hours, £2 2s.; No. 2, to burn 6 hours, £3 3s.; largest size, £5 5s. Set of 20 Quart Bunsen's Cells, £4 4s. Model Electric Lamp and 10 cells, £2 12s. 6d.

J. LANCASTER & SON,
OPTICIANS AND ELECTRICIANS,
BIRMINGHAM.
Catalogues, Three Stamps.

THE BIRKBECK BUILDING SOCIETY'S ANNUAL RECEIPTS EXCEED FOUR MILLIONS.

HOW TO PURCHASE A HOUSE FOR TWO GUINEAS PER MONTH,

With Immediate Possession and no Rent to pay.—Apply at the Office of the BIRKBECK BUILDING SOCIETY, 29 & 30, Southampton Buildings, Chancery Lane.

HOW TO PURCHASE A PLOT OF LAND FOR FIVE SHILLINGS PER MONTH,

With Immediate Possession, either for Building or Gardening purposes.—Apply at the Office of the BIRKBECK FREEHOLD LAND SOCIETY, 29 and 30, Southampton Buildings, Chancery Lane.

HOW TO INVEST YOUR MONEY WITH SAFETY.

Apply at the Office of the BIRKBECK BANK, 29 & 30, Southampton Buildings, Chancery Lane. Deposits received at varying rates of interest for stated periods, or repayable on demand.

Current Accounts opened with Persons properly introduced, and Interest allowed off the minimum monthly balances. English and Foreign Stocks and Shares purchased and sold, and Advances made thereon.

Office hours from 10 to 4; except on Saturdays, when the Bank closes at 2 o'clock. On Mondays the Bank is open until 9 o'clock in the Evening.

A Pamphlet, with full particulars, may be had on application.

FRANCIS RAVENSCROFT, Manager.

DARTON'S AUTOMATIC ELECTRIC LAMP,
FOR
Lecture Purposes, Exhibitions, &c.
WITH
REFLECTOR AND ADJUSTMENT FOR BOTTOM CARBON. Price 55/-

The same fitted in Lantern, with Apparatus for Showing the Spectra of Metals on a Screen to a Class. The whole packed in Case with Boxes containing Metals, Platinum, Pliers, Bisulphide of Carbon, Prism, &c. Complete £8 8s.

INVENTIONS WORKED OUT.

All kinds of Electrical Apparatus and Materials supplied to the Trade at lowest prices.
Price List of Electrical Bells and Trade Terms on Application.

F. DARTON & Co.
(Agents to the Science and Art Department),
45, ST. JOHN ST., WEST SMITHFIELD.

"NATURE" for MARCH 20th, 1879.

CONTENTS.

ROYAL AGRICULTURAL COLLEGE, CIRENCESTER.
PROFESSOR HUXLEY'S HUME. By Prof. J. VEITCH.
SACHS'S VENEZUELA.
OUR BOOK SHELF:—
  Bain's "Education as a Science."
  Davis's "Life in Asiatic Turkey."
LETTERS TO THE EDITOR.
ON THE POSSIBILITY OF EXPLAINING THE CONTINUANCE OF LIFE IN THE UNIVERSE CONSISTENT WITH THE TENDENCY TO TEMPERATURE-EQUILIBRIUM. By S. TOLVER PRESTON.
FRITZ MÜLLER ON A FROG HAVING EGGS ON ITS BACK.—ON THE ABORTION OF THE HAIRS ON THE LEGS OF CERTAIN CADDIS-FLIES, &c. By CHARLES DARWIN, F.R.S., and FRITZ MÜLLER. *(With Illustrations.)*
A STUDY IN LOCOMOTION, II. By Prof. MAREY. *(With Illustrations.)*
GEOLOGY OF NATAL AND ZULULAND. By CHARLES E. DE RANCE.
OUR ASTRONOMICAL COLUMN:—
  Prizes of the Paris Academy.
  Faye's Comet.
GEOGRAPHICAL NOTES.
EDISON'S TELEPHONE.
NOTES.
THE PARIS ACADEMY PRIZES.
UNIVERSITY AND EDUCATIONAL INTELLIGENCE.
SCIENTIFIC SERIALS.
SOCIETIES AND ACADEMIES.

HENRY WIGGIN & COMPANY,
(Late EVANS & ASKIN,)
COBALT AND NICKEL REFINERS AND GERMAN SILVER MANUFACTURERS,
BIRMINGHAM.
Anodes supplied for Nickel Plating, of any shape or dimensions.
Price according to size.

GENTLEMEN desirous of having "THE TELEGRAPHIC JOURNAL" forwarded to them regularly can have it sent by filling up this form and returning it to the Publishers, 10, Paternoster Row, London, E.C.

Please supply "The Telegraphic Journal" for the year 187 , for which I inclose Post Office Order for

*Name*______________________________

*Address*______________________________

*Date*____________________

Subscription: Post Free in Britain, nine shillings and fourpence; to countries in Postal Union, ten shillings and fourpence. P.O. Orders to be made payable to HAUGHTON & CO., at the Chief Office.

New York: D. Van Nostrand, 23, Murray Street, and 27, Warren Street. Paris: M. Breguet, 39, Quai de l'Horloge; Madame Veuve J. Boyveau, Librairie Etrangère, 22, Rue de la Banque.
Berlin: A. Asher & Co., 5, Unter den Linden.

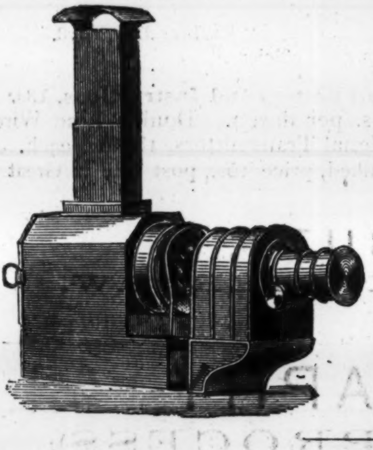
THE SCIOPTICON.

An improved form of Magic Lantern, burning paraffin oil, and giving a powerful light up to an 8 or 10 feet disc.

The Sciopticon was the first of these lanterns introduced, and still holds its place as the best among a host of imitations.

The principle of the light is two *parallel* flames placed edgewise to the condenser.

Always ready—a few seconds only required to put in operation.



The **Improved Sciopticon** is the only Lantern in the market constructed on scientific principles. It is arranged so that the whole of the light from the condensers passes through the front lenses, the focussing being done *with the slide*, thus giving a greatly increased light on the screen and much better definition. **Price £6 6s.**

Catalogue of Sciopticons and Appliances.

SCIOPTICON MANUAL OF INSTRUCTIONS AND EXPERIMENTS. 13 Stamps.

Fourth Edition in the Press.

WOODBURY LANTERN SLIDES.

Superior to all other photographic slides, being permanent pigment photographs, and printed in transparent colours, every gradation of shadow is brought out on the screen. Their warm tone also contrasts most favourably with the cold photographic colour.

THE SCENOGRAPH.

A very light and portable Tourist's Folding Pocket Camera. By the New Dry Process, Chemicals are left at home, and the Sensitive Plates developed at leisure. No previous knowledge necessary.

No. 1. For Pictures 4¼ × 3¼, with lens stand and can	35/-
No. 2. For Stereoscopes or Cabinets "	50/-
No. 3. For Pictures, 7 × 5 "	50/-

Well adapted for use of Engineers, &c., for taking photographs of machinery or progress of works. Manual of Instruction (with Photo) seven stamps.

SCIOPTICON COMPANY,
157, GREAT PORTLAND STREET, LONDON, W.

M. SADLER,

INVENTOR OF THE

UPRIGHT MAGNETIC MACHINE,

So universally used by the Medical Profession,

MANUFACTURER OF

Electrical, Galvanic, Magnetic, Chemical, Photographic, and Pneumatic Apparatus.

Electric Bells and Indicators of every description.

For Hotels, Warehouses, Manufactories, Mines, and Domestic and General Use.

19, ASTON STREET, BIRMINGHAM.

DAVIS & TIMMINS,

SCREW MANUFACTURERS.

Binders, Terminals, Connectors, Clamps, &c., Kept in Stock.

BOWLING GREEN LANE, FARRINGDON ROAD, E.C.

ELECTRIC HOUSE BELLS.

BURGLAR DETECTORS. FIRE ALARMS.

Electric Bells on the best system from 8s. 6d. each.

INDICATORS with Improved Mechanism. CONSTANT BATTERIES. WOOD & CHINA PUSH BUTTONS. INSULATED WIRE.

HOUSES & MANSIONS FITTED. ESTIMATES GIVEN.

ILLUSTRATED CATALOGUES with Diagrams, enabling everyone to fix their own Bells, Post free.

TESTIMONIAL.

"MESSRS. ARCHBUTT, "RUGBY, *May*, 1878."

"Your Electric Burglar Detectors fitted in my house last month have already proved efficient."

PROFESSOR HUGHES' MICROPHONE, price complete, with 3 Cell Battery and Instructions, 13s. Magnets of all descriptions. Silk covered Wire. Binding Screws, 3s. per dozen. Double Line Wire 1s. 6d. per dozen yards. Silk Cord. Switches, &c., &c. Telephone Signal Transmitters, 10*s*. 6*d*. each. **The Tourist's Friend**:—A PEDOMETER, registering distance walked, price 16s., post free in Great Britain and Ireland.

J. & W. E. ARCHBUTT,

8, BRIDGE STREET, WESTMINSTER, S.W.

FACING THE HOUSES OF PARLIAMENT.

PHOTOGRAPHY
(RAPID DRY PROCESS).

Previous Knowledge not necessary.

No Chemicals required in the field, Tourists' Pocket Camera and Slides, for Plates $4\frac{1}{4}$ by $3\frac{1}{4}$. Lens, Patent Folding Stand, Chemical Laboratory, and every requisite.

Price Complete, £8 8s.

THE SAME SET FOR PICTURES 5 × 4, £9 9s.

Practical Instruction Free.

Sensitive Plates 2s. 6d. per doz.

WRATTEN & WAINWRIGHT,

38, GREAT QUEEN ST., LONG ACRE, W.C.

EDWARD PATERSON,
MANUFACTURING ELECTRICIAN,
3, BEDFORD COURT, COVENT GARDEN.
STEAM WORKS—GRAY'S INN ROAD.

EXPERIMENTS IN ELECTRIC LIGHTING CARRIED OUT.

PATERSON'S ELECTRIC LAMP & BATTERY, for experiments with the Electric Light, £5 5s.
APPARATUS FOR SCIENCE SCHOOLS AND LECTURE PURPOSES.

RUHMKORFF COILS AND VACUUM TUBES.—Purchasers of more than £2 value of these can see them tested before purchasing.

Telephones, Telephone Calls, Telephone Wires, Electric Bells, Indicators, and Pushes.
SIEMENS' & GRAMMES' DYNAMO-MACHINE and LAMPS on Hire.
PROFESSOR S. P. THOMSON'S LANTERN SLIDE GALVANOMETER, &c.
New Illustrated Catalogue of 60 pages, post free 6 stamps.

THE TELEGRAPHIC JOURNAL,
10, PATERNOSTER ROW.

PUBLISHED ON THE 1st AND 15th OF EACH MONTH.

The scale of charges per insertion for Advertisements in this Journal is as follows:—

	£ s. d.		£ s. d.
Whole page	8 0 0	Whole column	4 0 0
Half "	4 0 0	Half "	2 0 0
Quarter "	2 0 0	Quarter "	1 0 0
Eighth "	1 0 0	Eighth "	0 10 0

Terms for a series according to contract.

Employees requiring Situations and Employers having Vacancies may Advertise Three Lines in Single Column without charge.

P.O. orders to be made payable to HAUGHTON AND Co., *at the Chief Office.*

THE PATENT ROBEY "ELECTRIC LIGHT" ENGINE.

SOME OF THE ADVANTAGES OF THIS ENGINE ARE:—
Small First Cost.
Saving of Time and Expense in Fixing.
No expensive Foundations, Brick Chimney, or separate Boiler House being required.
Ease, Safety, and Economy in Working.
Great Economy in Fuel.

PARIS, 1878.
GOLD MEDAL.

ALL ROBEY & Co.'s
ELECTRIC LIGHT ENGINES
Are Fitted with their
Patent High Speed Governor,
WHICH ENSURES
The Greatest Regularity and Steadiness in Working.

Engines of 4 to 200 Horse-Power always in stock or in progress. Photographs, full Particulars and Prices on application to the SOLE MANUFACTURERS,

ROBEY & Co., Engineers, Lincoln, England;
LONDON OFFICE, 117, CANNON STREET, E.C.

☞ REFERENCES CAN BE GIVEN TO UPWARDS OF 5900 ENGINES OF ALL SIZES FROM 2 HORSE-POWER TO 50 HORSE-POWER.

W. M. WARDEN & Co.,

TELEGRAPH ENGINEERS AND CONTRACTORS,

27, GREAT GEORGE STREET, WESTMINSTER, S.W.

Contractors for the Erection and Complete Equipment of Lines of Telegraph, and for the Supply of Telegraph Stores.

MANUFACTURERS OF IRON POLES AND TELEGRAPH WIRE.

ALSO OF EVERY DESCRIPTION OF

TELEGRAPH INSTRUMENTS AND APPARATUS.

W. M. WARDEN, of the late Firm of Warden, Muirhead and Clark.

WALTER HALL,

MANUFACTURER OF INSULATED WIRE,

For Electric Lighting, Telephones, and every description of Telegraphic Apparatus.

Silk and Cotton Covered Copper Wires, suitable for Electrical Instruments. German Silver Wires for Resistance Coils. Coils for Electric Bells. Needle and other Instruments Wound and Tested to order. India-Rubber, Gutta-Percha, and other kinds of Insulated Wire requisite in fitting up Electric Bells for domestic and other purposes. Telegraph Cables for Submarine, Subterranean and Aërial Telegraphs, Mines and Gunnery Experiments; also for Naval and Engineering purposes. Ebonite, Tissue, Gutta-Percha, Paraffin. India-Rubber and Shell-Lac Varnishes, &c., supplied.

Works: Mansfield Street, Southwark, S.E. City Office & Warehouses: 10, Love Lane, Wood Street, E.C.

INDIA-RUBBER, GUTTA-PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Offices and Warehouses: 106 & 100, CANNON ST., LONDON, E.C.

Works: Silvertown, Essex; Persan Beaumont, France.

TELEGRAPH ENGINEERS AND MANUFACTURERS OF

CABLES.—Submarine, Subterranean, and Aërial.

WIRE.—India-Rubber and Gutta-Percha covered in all gauges.

INSTRUMENTS.—"Morse" Inkers, Single Needle, Wheatstone's Alphabetical, Preece's & Walker's system of Semaphore "Block" Instruments, Bells, Resistance Coils, Sir W. Thomson's and other Galvanometers, Condensers, Testing Instruments, &c.

BATTERIES.—SOLE MANUFACTURERS FOR GREAT BRITAIN, IRELAND, AND THE COLONIES OF THE CELEBRATED LECLANCHE BATTERY, which has received the most favourable reports from Telegraph Engineers, and is in general use on English and Continental Railways. As a Battery for all Telegraphic purposes it is undoubtedly pre-eminent. All other kinds of Batteries also manufactured. Ebonite Cells, Carbon Plates, &c.

The Leclanché MEDICAL Battery is the best Medical Battery of the day.

INSULATORS.—Ebonite, Porcelain, Brownware, &c.

MANUFACTURERS OF THE MOST IMPROVED APPARATUS FOR RAILWAY BLOCK-SIGNALLING.

SEMAPHORE REPEATERS "LIGHT" INDICATORS, AND WALKER'S "PASSENGER AND GUARD" COMMUNICATOR.

TELEGRAPH STORES AND APPARATUS OF EVERY DESCRIPTION.

TORPEDO APPARATUS.

THE INDIA-RUBBER, GUTTA-PERCHA, & TELEGRAPH WORKS COMPANY (Limited) are Patentees and Manufacturers of a Complete System of Torpedoes for Harbour and Coast Defence, and of the

SILVERTOWN PATENT FIRING BATTERY,

A Constant Battery for Mining and Blasting Purposes.

CONTRACTS ENTERED INTO for the SUPPLY, CONSTRUCTION, and MAINTENANCE of TELEGRAPH LINES